

**NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH**

**STANDARD SPECIFICATIONS
FOR
ROADS AND STRUCTURES**



JANUARY 2012

FOREWORD

This publication has been prepared to provide a compilation of standard requirements used by the North Carolina Department of Transportation for construction contracts.

When this publication, entitled *Standard Specifications for Roads and Structures*, dated January 2012, is incorporated by reference into the Department's construction bid proposals or contracts; it is made a part of that document and shall be known as the *Standard Specifications*. The requirements stated herein may be revised or amended from time to time by Supplemental Specifications, by Standard Special Provisions which are unique to a select group of projects or by Project Special Provisions which are unique to the specific bid proposal or contract.

Working titles have a masculine gender, such as workman, workmen and foreman. Pronouns such as he, his, and him are used in the *Standard Specifications* for the sake of brevity and are intended to refer to persons of either sex and corporate entities.

Reference by title and date will be made to the governing provisions on plans and contract documents.

GENERAL INFORMATION

For general questions about this publication, please contact the Contract Standards and Development Unit at specs@ncdot.gov or (919) 707-6900.

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Copies of the *Standard Specifications* and the *Roadway Standard Drawings* may be purchased through the Contract Standards and Development Unit:

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DIVISION 1 GENERAL REQUIREMENTS

SECTION 101 DEFINITIONS OF TERMS

101-1 GENERAL

Whenever the terms defined in this section are used in the contract, in any of the contract documents, or in the plans, the intended meaning of such terms shall be as defined in this section.

101-2 ABBREVIATIONS

8	AASHTO	_____	American Association of State Highway and Transportation Officials
9	ABC	_____	Aggregate Base Course
10	ACI	_____	American Concrete Institute
11	AFAD	_____	Automated Flagger Assistance Device
12	AISC	_____	American Institute of Steel Construction
13	ANSI	_____	American National Standards Institute, Inc.
14	APL	_____	Approved Products List
15	ASC	_____	Approved Supplier Certification
16	ASB	_____	Aggregate Shoulder Borrow
17	ASTM	_____	American Society for Testing and Materials
18	AWG	_____	American Wire Gauge
19	AWS	_____	American Welding Society
20	AWWA	_____	American Water Works Association
21	AWPA	_____	American Wood-Preservers' Association
22	CAPWAP	_____	Case Pile Wave Analysis Program
23	CFR	_____	Code of Federal Regulations
24	CIE	_____	International Commission on Illumination
25	CRSI	_____	Concrete Reinforcing Steel Institute
26	C.S.	_____	Corrugated Steel
27	CSI	_____	Cumulative Straightedge Index
28	CSL	_____	Crosshole Sonic Logging
29	EIA/TIA	_____	Electronics Industries Alliance/Telecommunications Industry Association
30	ESAL	_____	Equivalent Single Axis Load
31	FHWA	_____	Federal Highway Administration, U.S. Department of Transportation
32	HDPE	_____	High Density Polyethylene
33	HMA	_____	Hot Mix Asphalt
34	ID	_____	Identification
35	IES	_____	Illuminating Engineering Society
36	IRI	_____	International Roughness Index
37	IMSA	_____	International Municipal Signal Association
38	JMF	_____	Job Mix Formula
39	LED	_____	Light Emitting Diode
40	LL	_____	Liquid Limit
41	LLC	_____	Limited Liability Company
42	LRFD	_____	Load and Resistance Factor Design
43	MIL	_____	Military Standard
44	MRAS	_____	Manufactured Waste Reclaimed Asphalt Shingles
45	MRI	_____	Mean Roughness Index
46	MSDS	_____	Material Safety Data Sheet
47	MTV	_____	Material Transfer Vehicle

Section 101

1	MUTCD	Manual on Uniform Traffic Control Devices and the North Carolina
2		Supplement thereto
3	NCAC	North Carolina Administrative Code
4	NCDENR	North Carolina Department of Environment and Natural Resources
5	NCDOT	North Carolina Department of Transportation
6	NCGS	North Carolina General Statutes
7	NEC	National Electrical Code
8	NEMA	National Electrical Manufacturers Association
9	NESC	National Electrical Safety Code
10	NTPEP	National Transportation Product Evaluation Program
11	OGAFC	Open-Graded Asphalt Friction Course
12	OSHA	Occupational Safety and Health Administration
13	OTDR	Optical Time Domain Reflectometer
14	PADC	Permeable Asphalt Drainage Course
15	PDA	Pile Driver Analyzer
16	PDF	Portable Document Format
17	PI	Plasticity Index (Material), Public Information Plan (Traffic Management)
18	PIT	Pile Integrity Testing
19	POC	Purchase Order Contract
20	PMEM	Polymer-Modified Emulsion Membrane
21	PRAS	Post Consumer Reclaimed Asphalt Shingles
22	PVC	Polyvinyl Chloride
23	PVCO	Molecularly Oriented Polyvinyl Chloride
24	QA	Quality Assurance
25	QC	Quality Control
26	QMS	Quality Management System
27	RAP	Reclaimed Asphalt Pavement
28	RAS	Reclaimed Asphalt Shingles
29	RUS	Rural Utilities Service
30	SCTE	Society of Cable Telecommunications Engineers
31	SMFO	Single Mode Fiber Optic (Cable or Connector)
32	SSPC	Society of Protective Coatings
33	SWG	Steel Wire Gauge
34	TIP	Transportation Improvement Plan
35	TMP	Traffic Management Plan
36	TO	Transportation Operations Plan
37	TSR	Tensile Strength Ratio
38	TTC	Temporary Traffic Control Plan
39	TTF	Temperature-Time Factor
40	UBWC	Ultra-thin Bonded Wearing Course
41	UL	Underwriters' Laboratories, Inc.
42	UST	Underground Storage Tank
43	UV	Ultraviolet
44	VEP	Value Engineering Proposal
45	VMA	Voids in Mineral Aggregate
46	VTM	Voids in Total Mix
47	WBS	Work Balance Sheet
48	WTAT	Wet Track Abrasion Test
49	WMA	Warm Mix Asphalt

TABLE 101-1 MEASUREMENT SYMBOLS			
Symbol	Unit Name	Symbol	Unit Name
"	Inch, Inches	kbps	Kilobit per Second
%	Percent	lb	Pound, Pounds
±	Plus or Minus	lbf	Pound(s) Force
°	Degree, Degrees	nm	Nanometer(s)
>	Greater Than	mcd/lux/m ²	Millicandellas per Lux per Square Meter
≥	Greater Than or Equal to	mg-cm	Milligram-Centimeter
<	Less Than	mm	Millimeter, Millimeters
≤	Less Than or Equal to	mph	Mile(s) per Hour
μ	Micro	oz	Ounce, Ounces
A, amp	Ampere, Amperes	ppm	Parts per Million
cf	Cubic Foot, Cubic Feet	psi	Pounds per Square Inch
cu.in.	Cubic Inch, Cubic Inches	qt	Quart, Quarts
cy	Cubic Yard, Cubic Yards	rpm	Rotations per Minute
dB	Decibel, Decibels	sec	Second, Seconds
F	Fahrenheit	sf	Square Foot, Square Feet
ft	Foot, Feet	SFS	Saybolt Furol Seconds
ft-lb	Foot-Pounds	sq.in.	Square Inch, Square Inches
gal	Gallon, Gallons	sy	Square Yard, Square Yards
gpm	Gallon(s) per Minute	tsf	Tons per Square Foot
G _{mm} @N _{ini}	Maximum Specific Gravity at Initial Number of Gyration	V, VAC	Voltage, Voltage of Alternating Current
hr	Hour, Hours	vpm	Vibrations per Minute
Hz	Hertz	W	Watt, Watts
J	Joule, Joules	Yd	Yard, Yards

1 101-3 DEFINITIONS

2 **ACT OF GOD:** Events in nature so extraordinary that the history of climate variations and
3 other conditions in the particular locality affords no reasonable warning of them.

4 **ADDITIONAL WORK:** Additional work is that which results from a change or alteration to
5 the contract and for which there are existing contract unit prices.

6 **ADMINISTRATOR:** The State Highway Administrator.

7 **ADVERTISEMENT:** The public advertisement inviting bids for the construction of specific
8 projects.

9 **AMOUNT BID:** The amount bid for a particular item of work in a proposal.

10 **ARTICLE:** A primary numbered subdivision of a section of the *Standard Specifications*.

11 **AWARD:** The decision of the Department of Transportation to accept the bid of the lowest
12 responsible responsive bidder for work that is subject to the furnishing of payment and
13 performance bonds and such other conditions as may be otherwise provided by law, the
14 proposal and these specifications.

15 **BASE COURSE:** That portion of the pavement structure of planned thickness placed
16 immediately below the pavement or surface course.

17 **BID (OR PROPOSAL):** *Paper Bid:* The offer of a bidder on the proposal furnished by the
18 Department to perform the work and to furnish the labor and materials at the prices quoted.
19 *Electronic Bid:* The electronic offer of a bidder via Bid Express® to the Department to
20 perform the work and to furnish the labor and materials at the prices quoted.

Section 101

- 1 **BID BOND OR BID DEPOSIT:** The security furnished by the bidder with his bid as
2 guaranty that he will furnish the required bonds and execute such documents as may be
3 required if his bid is accepted.
- 4 **BIDDER:** An individual, partnership, firm, corporation, LLC or joint venture formally
5 submitting a bid for the work contemplated.
- 6 **BOARD OR BOARD OF TRANSPORTATION:** The Board created by the provisions of
7 NCGS § 143B-350 for formulating policies for the Department of Transportation and
8 awarding all transportation construction contracts.
- 9 **BRIDGE:** A structure including supports, erected over a depression or an obstruction such as
10 water, highway or railway, and having a track or passage way for carrying traffic or other
11 moving loads and having a length measured along the center of the roadway of more than
12 20 ft between undercopings of end supports, spring lines of arches or between extreme ends
13 of openings for multiple reinforced concrete box structures.
- 14 **BRIDGE LENGTH:** The length of a bridge structure is the overall length measured along
15 the line of survey stationing back to back of backwalls of abutments, if present, otherwise end
16 to end of the bridge floor.
- 17 **BRIDGE WIDTH:** The clear width measured at right angles to the longitudinal centerline of
18 the bridge between the bottom of curbs, guard timbers or face of parapets, or in the case of
19 multiple heights of curbs, between the bottoms of the lower risers.
- 20 **CALENDAR DAY:** A day shown on the calendar beginning and ending at midnight.
- 21 **CHIEF ENGINEER:** The Chief Engineer, Operations, Division of Highways,
22 North Carolina Department of Transportation acting directly or through his duly authorized
23 representatives.
- 24 **COMPLETION DATE:** That date established as set forth in the contract or as revised by
25 authorized extensions, by which it is required that the work set forth in the contract be
26 satisfactorily completed. When observation periods are required by the Specifications, they
27 are not a part of the work to be completed by the completion date or intermediate contract
28 times stated in the contract unless otherwise noted.
- 29 **CONSTRUCTION EASEMENT:** A right owned by the Department of Transportation in
30 a parcel of land owned by a third party outside the highway right of way for containing
31 construction that exceeds the right of way.
- 32 **CONTRACT:** The executed agreement between the Department and the successful bidder,
33 covering the performance of and compensation for the work.
- 34 The term contract is all inclusive with reference to all written and electronic agreements
35 affecting a contractual relationship and all documents referred to therein. The contract shall
36 include, but not be limited to, the proposal, the printed contract form and attachments,
37 contract bonds, plans, standard specifications and supplemental specifications, standard
38 special provisions and project special provisions contained in the proposal and all executed
39 supplemental agreements.
- 40 All references to contracts shall include electronic agreements and printed paper agreements.
41 These may include, but not be limited to, the electronic bid bond, Non-Collusion Affidavit,
42 Debarment Certification, Gift Ban Certification and award limits.
- 43 The contract shall constitute one instrument.
- 44 **CONTRACT ITEM:** A specifically described unit of work for which a unit or lump sum
45 price is provided in the contract. Synonymous with Pay Item.
- 46 **CONTRACT LUMP SUM PRICE:** The amount bid for a lump sum item that has been
47 submitted by the Contractor in his proposal.

- 1 **CONTRACT PAYMENT BOND:** A bond furnished by the Contractor and his corporate
2 surety securing the payment of those furnishing labor, materials and supplies for the
3 construction of the project.
- 4 **CONTRACT PERFORMANCE BOND:** A bond furnished by the Contractor and his
5 corporate surety guaranteeing the performance of the contract.
- 6 **CONTRACT TIME:** The number of calendar days inclusive between the date of availability
7 and the completion date, said dates being established as set forth in the special provisions,
8 including authorized extensions to the completion date.
- 9 **CONTRACT UNIT PRICE:** The unit bid price for a unit item that has been submitted by
10 the Contractor in his proposal.
- 11 **CONTRACTOR:** The successful bidder to whom the contract has been awarded, and who
12 has executed the contract and furnished acceptable contract bonds.
- 13 **CULVERT:** Any structure not classified as a bridge that provides an opening under the
14 roadway.
- 15 **CURRENT CONTROLLING OPERATION OR OPERATIONS:** Any operation or
16 operations, as determined by the Engineer, that if delayed would delay the completion of the
17 project.
- 18 **DATE OF AVAILABILITY:** That date, established as set forth in the special provisions, by
19 which it is anticipated that sufficient work sites within the project limits will be available for
20 the Contractor to begin his controlling operations that are not otherwise limited by
21 moratoriums, listed third party conflicts, or by weather conditions.
- 22 **DEPARTMENT or DEPARTMENT OF TRANSPORTATION:** A principal department
23 of the Executive Branch that performs the functions of planning, design, construction and
24 maintenance of an integrated statewide transportation system.
- 25 **DIVISION OF HIGHWAYS:** The division of the Department of Transportation that, under
26 the direction of the Secretary of Transportation, carries out state highway planning, design,
27 construction and maintenance functions assigned to the Department of Transportation.
- 28 **DRAINAGE EASEMENT:** A right, owned by the Department of Transportation, in a parcel
29 of land owned by a third party outside the highway right of way, to construct and maintain
30 ditches, channels, or structures for directing the course and flow of water outside the highway
31 right of way.
- 32 **EASEMENT:** A property right to use or control real property of another.
- 33 **ENGINEER:** The State Highway Administrator of the North Carolina Department of
34 Transportation, acting directly or through a duly authorized representative, such
35 representative acting within the scope of particular assigned duties or authority.
- 36 **EQUIPMENT:** All machinery and equipment, together with the necessary supplies, tools
37 and apparatus for upkeep and maintenance, all of which are necessary for the proper
38 construction and acceptable completion of the work.
- 39 **EXTRA WORK:** Work found necessary or desirable to fully complete the work as
40 contemplated in the contract for which payment is not provided for by the contract unit or
41 lump sum prices in the original contract. Extra work shall not be work that in the terms of the
42 contract is incidental to work for which there is a contract price or work that payment is
43 included in some other contract unit or lump sum price.
- 44 **FINAL ACCEPTANCE DATE:** That date on which all work set forth in the contract and
45 work modified by the Engineer is satisfactorily completed excluding any observation periods
46 not specifically made a part of the work by the specifications or special provisions.

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- 1 **FINAL ESTIMATE:** The document that contains a final statement of all quantities and total
2 dollar amount for each item of work performed during the life of the contract including any
3 adjustments to those amounts made under the terms of the contract. The final statement will
4 be titled The Final Estimate and will be the document used to document final payment to the
5 Contractor. Receipt of this document by the Contractor will begin the time frame for filing of
6 a verified claim with the Department as provided for in NCGS § 136-29.
- 7 **FINAL ESTIMATE ASSEMBLY:** As constructed plans and other project records that
8 establish the final statement of quantities to be paid and document work performed on the
9 project.
- 10 **FORCE ACCOUNT NOTICE:** A written notice to the Contractor that extra work ordered
11 by the Engineer will be paid as force account work.
- 12 **FORCE ACCOUNT WORK:** Work that is paid in accordance with Article 109-3 or on the
13 basis of the force account formula provided in the contract.
- 14 **HIGHWAY:** A general term denoting a public way for purposes of vehicular travel,
15 including the entire area within the right of way. Synonymous with Road and Street.
- 16 **HOURLY:** One of the 24 equal parts of a day.
- 17 **INSPECTOR:** The authorized representative of the Engineer assigned to make a detailed
18 inspection of any or all portions of the work and materials.
- 19 **INTERMEDIATE COMPLETION DATE:** That date established as set forth in the special
20 provisions or as revised by authorized extensions, by which date it is required that the portion
21 of work set forth in the contract be satisfactorily completed.
- 22 **INTERMEDIATE COMPLETION TIME:** The time established as set forth in the special
23 provisions or as revised by authorized extensions, by which it is required that the portion of
24 work set forth in the contract be satisfactorily completed.
- 25 **INTERMEDIATE CONTRACT TIME (DAYS):** The number of calendar days inclusive
26 between the date of availability and the completion date, said days being established as set
27 forth in the special provisions, or as revised by authorized extensions, by which it is required
28 that a portion of that work set forth in the contract be satisfactorily completed.
- 29 **INTERMEDIATE CONTRACT TIME (HOURS):** The number of hours inclusive
30 between the time of availability and the intermediate completion time, said times being
31 established as set forth in the special provisions, including authorized extensions to the
32 intermediate completion time.
- 33 **INVERT:** The lowest point in the internal cross section of a pipe or other culvert.
- 34 **INVITATION TO BID:** The notification that bids will be received for the construction of
35 specific projects.
- 36 **LABORATORY:** The testing laboratory of the Department of Transportation or any other
37 testing laboratory that may be designated or approved by the Engineer.
- 38 **LOCAL TRAFFIC:** Traffic that must use the facility under construction to reach its
39 destination.
- 40 **MAJOR AND MINOR CONTRACT ITEMS:** Major contract items are listed as such in
41 the project special provisions. All other original contract items and extra work shall be
42 considered as minor items.
- 43 **MATERIALS:** Any substances that may be incorporated into the construction of the project.
- 44 **MEDIAN:** The center section of a divided highway that separates the traffic lanes in one
45 direction from the traffic lanes in the opposite direction.
- 46 **MOBILIZATION:** The work described in Article 800-1.

- 1 **PAVEMENT STRUCTURE:** The combination of base and surface courses placed on
2 a subgrade to support the traffic load and distribute it to the roadbed.
- 3 **PAY ITEM:** Synonymous with Contract Item.
- 4 **PLANS:** The approved plans, profiles, typical roadway sections, appropriate standard
5 drawings, supplemental plans and working drawings, or exact reproductions thereof, that
6 show the location, dimensions and details of the work to be done and that are a part of the
7 contract.
- 8 **PREBID CONFERENCE:** A conference held before bids are accepted on a project at which
9 representatives of the Department will provide information and accept and answer questions
10 from interested parties.
- 11 **PROJECT:** The work specified under the contract.
- 12 **PROJECT SPECIAL PROVISIONS:** Special provisions peculiar to the project and not
13 otherwise thoroughly or appropriately set forth in the standard specifications or plans.
- 14 **PROPOSAL:** The electronic or paper document provided by the Department that the bidder
15 uses to develop his electronic or paper offer to perform the work at designated bid prices.
- 16 **RIGHT OF WAY:** The land area shown in the plans as right of way to be furnished by the
17 Department of Transportation within which the project is to be constructed.
- 18 **ROAD:** Synonymous with Highway and Street.
- 19 **ROADBED:** The graded portion of a highway usually considered as the area between the
20 intersections of top and side slopes, upon which the base course, surface course, shoulders and
21 medians are constructed.
- 22 **ROADSIDE:** A general term denoting the area within the limits of the right of way adjoining
23 the outer edge of the roadway. Extensive areas between the roadways of a divided highway
24 may be considered roadside.
- 25 **ROADWAY:** The portion of a highway within limits of construction.
- 26 **SECTION:** A numbered chapter of the standard specifications.
- 27 **SHOULDER:** The portion of the roadway adjacent to the traveled way for accommodation
28 of stopped vehicles, for emergency use and for lateral support of base and surface courses.
- 29 **SIDEWALK:** That portion of the roadway primarily constructed for pedestrian traffic.
- 30 **SKEW ANGLE:** The angle between the centerline of the project and the centerline of a pipe,
31 culvert, bridge pier, bent, abutment, or other drainage feature, measured to the right of the
32 project centerline facing in the direction of progressing stations.
- 33 **SPECIAL PROVISIONS:** Project special provisions and standard special provisions taken
34 together as one body of special provisions.
- 35 **SPECIFICATIONS:** The general term comprising all the directions, provisions and
36 requirements contained or referred to in the *Standard Specifications*, including the
37 Supplemental Specifications, together with such additional directions, provisions and
38 requirements that may be added or adopted as special provisions.
- 39 **STANDARD DRAWINGS:** The general term comprising all the directions, provisions and
40 requirements contained or referred to in the book entitled *Roadway Standard Drawings* and in
41 any subsequent revisions or additions to such book that are issued as Detail Drawings.
- 42 **STANDARD SPECIAL PROVISIONS:** Special directions or requirements not otherwise
43 thoroughly or appropriately set forth in the standard specifications and that are peculiar to
44 a selected group of projects.

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- 1 **STANDARD SPECIFICATIONS:** The general term comprising all the directions,
2 provisions and requirements contained or referred to in this book entitled *Standard*
3 *Specifications for Roads and Structures* and in any subsequent revisions or additions to such
4 book that are issued as Supplemental Specifications.
- 5 **STATE:** The State of North Carolina.
- 6 **STATION:** A station, when used as a term of measurement, will be 100 linear feet measured
7 horizontally. When used as a location, it will be a designated point on the project.
- 8 **STREET:** Synonymous with Highway and Road.
- 9 **SUBCONTRACTOR:** An individual, partnership, firm, joint venture, LLC or corporation to
10 whom the Contractor, with the written consent of the Engineer, sublets any part of the
11 contract.
- 12 **SUBGRADE:** That portion of the roadbed prepared as a foundation for the pavement
13 structure including curb and gutter. On portions of projects that do not include the
14 construction of a base course or pavement, the presence of the subgrade will not be
15 recognized during the life of such contract.
- 16 **SUBSTRUCTURE:** All of that part of the structure below the bearings of simple and
17 continuous spans, spans, skew back of arches and tops of footings of rigid frames, together
18 with the backwalls and wingwalls.
- 19 **SUCCESSFUL BIDDER:** The bidder awarded a contract.
- 20 **SUPERINTENDENT:** The representative of the Contractor authorized to supervise and
21 direct the construction for the Contractor and to receive and fulfill directions from the
22 Engineer.
- 23 **SUPERSTRUCTURE:** All of the part of the structure exclusive of the substructure.
- 24 **SUPPLEMENTAL AGREEMENT:** A written agreement between the Contractor and the
25 Department of Transportation covering amendments to the contract.
- 26 **SUPPLEMENTAL SPECIFICATIONS:** Specifications, regulations, standards, manuals or
27 codes referenced in the contract or general revisions or additions to this book of standard
28 specifications that are issued under the title of Supplemental Specifications. Supplemental
29 Specifications shall be considered part of the *Standard Specifications*.
- 30 **SURETY:** A corporate bonding company furnishing the bid bond or furnishing the contract
31 payment and performance bonds.
- 32 **TEMPORARY CONSTRUCTION EASEMENT:** A temporary right, owned by the
33 Department of Transportation, in a parcel of land owned by a third party outside the highway
34 right of way, for the use of the Department of Transportation during the construction and that
35 reverts to the third party on completion of construction.
- 36 **THROUGH TRAFFIC:** Traffic that can reach its destination by a route or routes other than
37 the facility under construction.
- 38 **TIME OF AVAILABILITY:** That time established as set forth in the special provisions, by
39 which it is anticipated that sufficient work sites within the project limits will be available for
40 the Contractor to begin his controlling operations.
- 41 **TOTAL AMOUNT BID:** Same as total price bid. The total amount bid will be considered
42 to be the correct sum total obtained by adding together the amounts bid for every item in the
43 proposal other than items that are authorized alternates to those items for which an amount bid
44 has been established.
- 45 **UNBALANCED BID:** A bid that includes any unbalanced bid price.

1 **UNBALANCED BID PRICE:** A unit or lump sum bid price that does not reflect reasonable
 2 actual costs that the bidder anticipates for the performance of the item in question along with
 3 a reasonable proportionate share of the bidder's anticipated profit, overhead costs and other
 4 indirect costs.

5 **WORK:** Work shall mean the furnishing of all labor, materials, equipment and incidentals
 6 necessary or convenient to the successful completion of the project, or any part, portion or
 7 phase thereof, and the carrying out of all duties and obligations imposed by the contract.

8 **WORKING DRAWINGS:** Stress sheets, shop drawings, erection drawings, falsework
 9 drawings, cofferdam drawings, catalog cuts, or any other supplementary drawings or similar
 10 data that the Contractor is required to submit to the Engineer for review or approval.

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12 BIDDING REQUIREMENTS AND CONDITIONS

13 102-1 INVITATION TO BID

14 After the advertisement has been made, an Invitation to Bid will be made available on the
 15 Department's website to interested parties, informing them that bids will be received for the
 16 construction of specific projects. Such invitations will indicate the contract identification
 17 number, length, locations and descriptions; a general summary of the items and approximate
 18 quantities of work to be performed; and the time and place for the public opening and reading
 19 of the bids received. Information concerning the cost and availability of plans and proposals
 20 will be indicated in the Invitation to Bid.

21 All projects will be advertised in daily newspapers throughout the state before the bid
 22 opening.

23 102-2 CONTRACTOR PREQUALIFICATION

24 Contractors desiring to perform work on Department projects shall prequalify with the
 25 Department. Upon prequalification, contractors will be placed on the Department's
 26 Prequalified Contractors' List. The requirements for prequalification are as follows:

27 (A) Bidder Prequalification

- 28 (1) Applicant shall submit a completed Bidder Experience Questionnaire, along with any
 29 additional supporting information requested by the Department, as noted in the
 30 experience questionnaire package. Additional requirements for prequalification may
 31 be set forth in the bid proposal.
- 32 (2) Applicant shall demonstrate that he has sufficient ability and experience in related
 33 transportation construction projects to perform the work specified in the
 34 Department's contracts, including the type and dollar value of previous contracts.
- 35 (3) Applicant shall demonstrate a history of successful performance and completion of
 36 projects in a timely manner, subject to contract time adjustments.
- 37 (4) Applicant shall demonstrate the financial ability to furnish bonds as specified in
 38 NCGS § 44A-26 and any other relevant statutes.
- 39 (5) Applicant shall demonstrate sufficient and readily available equipment to perform
 40 transportation construction contracts in a timely manner.
- 41 (6) Applicant shall demonstrate sufficient available experienced personnel to perform
 42 transportation construction contracts. The identities and qualifications of both
 43 management and labor work force shall be provided.
- 44 (7) Applicant shall provide names and addresses of persons for whom the firm has
 45 performed related work. Responses from the references shall be on Department
 46 forms and shall be received by the Department before evaluating the request for
 47 prequalification.

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1 (8) Applicant shall provide any information requested concerning the corporate and
2 operational management structure of the company, the identity of persons or entities
3 owning stock or other equity interest in the company, and the relationship between
4 the applicant and any other company prequalified or applying for prequalification
5 with the Department.

6 (9) Applicant shall demonstrate, at the time of application for prequalification, the
7 financial capacity to successfully complete projects containing the work types they
8 so designate.

9 (10) Applicant shall provide further information as may be required to determine that the
10 firm is a responsible bidder.

11 (11) Applicant shall submit an original completed Pre-Bid Non-Collusion Affidavit,
12 Debarment Certification and Gift Ban Certification in accordance with Article 102-9.
13 These forms can be found on the Department's website.

14 (12) Applicant shall submit a completed Safety Index Rating Form with the Questionnaire
15 and annually thereafter in accordance with Subarticle 102-2(D).

16 Bidders shall renew annually and shall requalify every 3 years in accordance with
17 Subarticle 102-2(E).

18 The Bidder Experience Questionnaire shall be completed in its entirety and signed by
19 an officer of the firm. The officer's signature shall be notarized. In addition to
20 submitting the Bidder Experience Questionnaire, the prospective bidder shall submit
21 supporting information in a format of his choosing to address the requirements listed
22 above.

23 It is recommended that the prospective bidder file all required statements and documents
24 with the State Contractual Services Engineer no less than 4 weeks before a given letting.
25 A bid shall not be opened unless all prequalification requirements have been met by the
26 bidder and have been found acceptable by the Engineer.

27 **(B) Purchase Order Contractor Prequalification**

28 Contractors who have been approved to be placed on the Prequalified Bidders' List as
29 noted above may perform work for the Department as a Purchase Order Contractor and
30 need not apply further. However, Purchase Order Contractors will not be placed on the
31 Prequalified Bidders' List unless they submit through the prequalification process
32 described above.

33 (1) Applicant shall submit a completed Department Purchase Order Contractor
34 Application along with any additional supporting information requested by the
35 Department, as noted in the application. Additional requirements for
36 prequalification may be in the bid proposal.

37 (2) Applicant shall demonstrate that it has sufficient ability and experience in related
38 transportation construction projects to perform the work specified in Department
39 contracts, including the type and dollar value of previous contracts.

40 (3) Applicant shall demonstrate a history of successful performance and completion of
41 projects in a timely manner, subject to contract time adjustments.

42 (4) Applicant shall demonstrate the financial ability to furnish bonds as specified in
43 NCGS § 44A-26 if the applicant intends to pursue contracts exceeding \$500,000.

44 (5) Applicant shall demonstrate sufficient and readily available equipment to perform
45 transportation construction contracts in a timely manner.

46 (6) Applicant shall provide further information as may be required to determine that the
47 firm is a responsible contractor.

1 (7) Applicant shall submit an original completed Pre-Bid Non-Collusion Affidavit,
2 Debarment Certification and Gift Ban Certification. These forms can be found on
3 the Department's website.

4 (8) Applicant shall submit a completed Safety Index Rating Form with the application
5 and annually thereafter in accordance with Subarticle 102-2(D).

6 Contractors shall renew annually and requalify every 3 years in accordance with
7 Subarticle 102-2(E).

8 The application shall be completed in its entirety and signed by an officer of the firm.
9 The officer's signature shall be notarized. In addition to submitting the application, the
10 firm shall submit supporting information in a format of his choosing to address the
11 requirements listed above.

12 It is recommended that the applicant file all required statements and documents with the
13 State Contractual Services Engineer no less than 4 weeks before a given bid opening for
14 their bid to be considered. A bid shall not be opened unless all prequalification
15 requirements have been met by the applicant and have been found acceptable by the
16 Engineer.

17 **(C) Subcontractor Prequalification**

18 Contractors who have been approved to be placed on the Prequalified Bidders' List or the
19 POC Prime Contractors' List as noted above may perform work for the Department as
20 a subcontractor and need not apply further. However, subcontractors will not be placed
21 on the Prequalified Bidders' List unless they submit through the prequalification process
22 described above.

23 (1) Applicant shall submit a completed Subcontractor Application along with any
24 additional supporting information requested by the Department. Additional
25 requirements for prequalification may be in the bid proposal.

26 (2) Applicant shall demonstrate sufficient ability and experience in related transportation
27 construction projects to perform the work specified in Department contracts,
28 including the type of previous contracts.

29 (3) Applicant shall demonstrate sufficient and readily available equipment to perform
30 transportation construction contracts in a timely manner.

31 (4) Applicant shall submit a completed Safety Index Rating Form with the Subcontractor
32 Application and annually thereafter in accordance with Subarticle 102-2(D).

33 (5) Applicant shall provide further information as may be required.

34 Subcontractors shall renew annually and shall requalify every 3 years in accordance with
35 Subarticle 102-2(E).

36 The Subcontractor Application shall be completed in its entirety. In addition to
37 submitting the Subcontractor Application, the prospective subcontractor shall submit
38 supporting information in a format of their choosing to address the requirements listed
39 above.

40 The subcontractor shall file all required statements and documents with the State
41 Contractual Services Engineer no less than 4 weeks before beginning work.
42 A subcontractor will not be allowed to begin work until all prequalification requirements
43 have been met by the subcontractor and have been found acceptable by the Engineer.

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(D) Safety Index

The Department will conduct a review of each firm's safety index. To be prequalified, each firm shall maintain a satisfactory safety index. An overall safety index of at least 60 is considered satisfactory. An index between 60 and 69 may be considered marginal and may result in an in-depth safety audit of a firm's safety practices. An overall safety index equal to or less than 59 is considered unsatisfactory and will prohibit prequalification of new firms.

A score of 59 or less for renewing or requalifying firms will result in disciplinary action pursuant to Subarticles 102-2(D)(1) through 102-2(D)(4). The Engineer may require the Contractor to state in writing the reason for the unsatisfactory rating and produce such supporting data as may be necessary to evaluate the circumstances surrounding the rating. When the Contractor cannot provide justification to raise the unsatisfactory safety index, the Engineer may invoke one or more of the following sanctions:

- (1) Removal of the firm from the Prequalified Contractors' List,
- (2) Placement of the firm on probation for up to 2 years,
- (3) Auditing of the firm's safety practices and
- (4) Giving a written warning to correct any safety deficiencies.

Firms not approved or disqualified to bid or perform subcontract work due to an unsatisfactory safety index will not be approved or reinstated to bid or perform subcontract work until they can provide adequate evidence that all safety deficiencies have been corrected to the satisfaction of the Engineer.

(E) Renewal and Requalification

Renewal of firms shall occur annually on or before the firm's anniversary date. Renewal shall consist of submitting an updated application. Bids of firms who fail to submit these documents by their anniversary date will not be considered until such time as these documents are received and approved by the Engineer. The Engineer may review performance related issues when considering firms for renewal. Subcontractors who fail to submit these documents by their anniversary date will not be allowed to begin work on any new contracts until these documents are received and approved by the Engineer.

Requalifying of firms shall occur every 3 years. Requalifying shall consist of submitting an updated application. Bids of firms who fail to submit these documents by their anniversary date will not be considered until such time as these documents are received and approved by the Engineer. The Engineer may review performance related issues when considering firms for requalification. Subcontractors who fail to submit these documents by their anniversary date will not be allowed to begin work on any new contracts until these documents are received and approved by the Engineer.

It is recommended that the renewing or requalifying firm file all required statements and documents with the State Contractual Services Engineer no less than 4 weeks before a given letting for their bid to be considered. Following the anniversary date, a bid will not be opened unless all renewal or requalification requirements have been met by the bidder and have been found acceptable by the Engineer. Following the anniversary date, a subcontractor may not begin any new work unless all renewal or requalification requirements have been met by the firm and have been found acceptable by the Engineer.

102-3 PROPOSALS AND PLAN HOLDER LISTS

On Department projects advertised through the Raleigh Central Office, the bidder shall purchase a proposal for each project for which he intends to submit a bid. The prospective bidder will be required to pay the Department the sum stated in the Invitation to Bid for each copy of the proposal and set of plans purchased.

1 This proposal will state the location of the contemplated construction and show a schedule of
2 contract items with the approximate quantity of each of these items for which bid prices are
3 invited. It will set forth the date and time for the opening of bids. The proposal will include
4 any special provisions or requirements that vary from, or are not contained in, the plans or
5 *Standard Specifications*.

6 The plans, *Standard Specifications* and other documents designated in the proposal shall be
7 considered a part of the proposal whether or not attached.

8 The names and identity of corporations, firms, partnerships, individuals, LLCs or joint
9 ventures who have requested plans or proposals for the purposes of bidding shall be made
10 public, except that a potential bidder who obtains a set of plans/proposals may, at the time of
11 ordering, request that his name remain confidential.

12 (A) Paper Bids

13 The proposal will include the printed contract forms and signature sheets for execution by
14 both parties to the contract. In the event the bidder is awarded the contract, execution of
15 the bid by the bidder is considered the same as execution of the contract.

16 All papers bound with the proposal are necessary parts thereof and shall not be detached,
17 taken apart or altered.

18 (B) Electronic Bids

19 The bidder shall bid in accordance with Subarticle 102-8(B).

20 102-4 COMBINATION BIDS

21 If the Department so elects, proposals may be issued for projects in combination or separately,
22 so that bids may be submitted either on the combination or on separate units of the
23 combination. The right is reserved to make awards on combination bids or separate bids to
24 the best advantage of the Department. No combination bids, other than those specified by the
25 Department in the proposal will be considered.

26 102-5 INTERPRETATION OF QUANTITIES IN PROPOSAL

27 The quantities appearing in the proposal are approximations only and are to be used solely for
28 the comparison of bids. Payment to the Contractor will be made in accordance with the
29 contract.

30 When revisions in the plans are made by the Engineer that affect the quantities shown for
31 lump sum items, adjustment in compensation may be made under the provisions of
32 Articles 104-3 or 104-7.

33 102-6 EXAMINATION OF PLANS, SPECIFICATIONS, CONTRACT AND SITE 34 OF WORK

35 The bidder shall examine carefully the site of the work contemplated, the plans and
36 specifications, and the proposals and contracts therefor. The submission of a bid shall be
37 conclusive evidence that the bidder has investigated and is satisfied as to the conditions to be
38 encountered; the character, quality and scope of work to be performed; the quantities of
39 materials to be furnished; and the conditions and requirements of the proposal, plans and
40 contract under which his bid is offered.

41 A bidder or contractor is cautioned to make such independent investigation and examination
42 as he deems necessary to satisfy himself as to conditions to be encountered in the performance
43 of the work and with respect to possible local material sources, the quality and quantity of
44 material available from such property, and the type and extent of processing that may be
45 required to produce material conforming to the contract.

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1 102-7 SUBSURFACE INVESTIGATION REPORT

2 If a subsurface investigation report is available on a project, a copy may be obtained by the
3 plan holders upon request.

4 The subsurface report and the subsurface investigation on which it is based was made for
5 study, planning and design and not for construction or pay purposes. The various field boring
6 logs, rock cores and soil test data available may be reviewed or inspected in Raleigh at the
7 office of the Geotechnical Engineering Unit. Neither the subsurface investigation report nor
8 the field boring logs, rock cores, or soil test data is part of the contract.

9 General soil and rock strata descriptions and indicated boundaries are based on a geotechnical
10 interpretation of all available subsurface data and may not necessarily reflect the actual
11 subsurface conditions between borings or between sampled strata within the borehole. The
12 laboratory sample data and the in-place test data can be relied on only to the degree of
13 reliability inherent in the standard test method. The observed water levels or soil moisture
14 conditions indicated in the subsurface investigations are as recorded at the time of the
15 investigation. These water levels or soil moisture conditions may vary considerably with time
16 according to climatic conditions including temperature, precipitation and wind, as well as
17 other nonclimatic factors.

18 The bidder or contractor is cautioned that details shown in the subsurface investigation report
19 are preliminary only; the final design details may be different. For bidding and construction
20 purposes, refer to the contract for final design information on this project. The Department
21 does not warrant or guarantee the sufficiency or accuracy of the investigation made, nor the
22 interpretations made or opinions of the Department as to the type of materials and conditions
23 that may be encountered. The bidder or contractor is cautioned to make independent
24 subsurface investigations, as he deems necessary, to satisfy himself as to conditions to be
25 encountered on this project. The Contractor shall have no claim for additional compensation
26 or for an extension of time for any reason resulting from the actual conditions encountered at
27 the site differing from those indicated in the subsurface investigation.

28 102-8 PREPARATION AND SUBMISSION OF BIDS

29 The bidder shall submit a unit or lump sum price for every item in the proposal other than
30 items that are authorized alternates to those items for which a bid price has been submitted.

31 An amount bid shall be entered in the proposal for every item on which a unit price has been
32 submitted. As an exception to the above, when the proposal permits a bidder to submit a bid
33 on only a portion of the work covered by the entire proposal, the bidder shall then submit
34 a unit or lump sum price for every item constituting that portion of the work on which the
35 bidder has elected to place a bid other than items that are authorized alternates to those items
36 for which a bid price has been submitted.

37 In the case of lump sum items, the price shall be written in figures in the Amount Bid column
38 in the proposal.

39 The bid shall not contain any unauthorized additions, deletions or conditional bids.

40 The bidder shall not add any provision reserving the right to accept or reject an award or to
41 enter into a contract pursuant to an award.

42 The bid shall not be an unbalanced bid.

43 (A) Paper Bids

44 (1) The proposal provided by the Department shall be used and shall not be taken apart
45 or altered. The bid shall be submitted on the same proposal that has been furnished
46 to the bidder by the Department.

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- 1 The bid shall be accompanied by a bid bond on the form furnished by the
2 Department or by a bid deposit. The bid bond shall be completely and properly
3 executed in accordance with Article 102-10. The bid deposit shall be a certified
4 check or cashier's check in accordance with Article 102-10.
- 5 (2) All entries including signatures shall be written in ink.
- 6 (3) The unit prices shall be rounded off by the bidder to contain no more than 4 decimal
7 places.
- 8 (4) An amount bid shall be entered in the proposal for every item on which a unit price
9 has been submitted. The amount bid for each item other than lump sum items shall
10 be determined by multiplying each unit bid price by the quantity for that item and
11 shall be written in figures in the Amount Bid column in the proposal.
- 12 (5) In the case of lump sum items, the price shall be written in figures in the Amount Bid
13 column in the proposal.
- 14 (6) The total amount bid shall be written in figures in the proper place in the proposal.
15 The total amount bid shall be determined by adding the amounts bid for each item.
- 16 (7) Changes in any entry shall be made by marking through the entry in ink and making
17 the correct entry adjacent thereto in ink. A representative of the bidder shall initial
18 the change in ink.
- 19 (8) The bid shall be properly executed. To constitute proper execution, the bid shall be
20 executed in strict compliance with the following:
- 21 (a) If a bid is by an individual, it shall show the name of the individual and shall be
22 signed by the individual with the word *Individually* appearing under the
23 signature. If the individual operates under a firm name, the bid shall be signed
24 in the name of the individual doing business under the firm name.
- 25 (b) If the bid is by a corporation, the President, Vice President, or Assistant Vice
26 President shall execute it in the name of the corporation. The Secretary or
27 Assistant Secretary shall attest it. The seal of the corporation shall be affixed. If
28 the bid is executed on behalf of a corporation in any other manner than as above,
29 a certified copy of the minutes of the Board of Directors of said corporation
30 authorizing the manner and style of execution and the authority of the person
31 executing shall be attached to the bid or shall be on file with the Department.
- 32 (c) If the bid is made by a partnership, it shall be executed in the name of the
33 partnership by one of the general partners.
- 34 (d) If the bid is made by a limited liability company, it shall be signed by the
35 manager, member or authorized agent and notarized.
- 36 (e) If the bid is a joint venture, it shall be executed by each member of the joint
37 venturers in the appropriate manner set out above. In addition, the execution by
38 the joint venturers shall appear below their names.
- 39 (f) The bid execution shall be notarized by a notary public whose commission is in
40 effect on the date of execution. Such notarization shall be applicable both to the
41 bid and to the Non-Collusion Affidavit, Debarment Certification and Gift Ban
42 Certification that is part of the signature sheets.
- 43 (9) The bid shall be placed in a sealed envelope and shall have been delivered to and
44 received by the Department before the time specified in the Invitation to Bid.

Section 102

1 (B) Electronic Bids

2 The Department will not be responsible if a bidder cannot submit his bid to Bid
3 Express®. Claims will not be accepted for such failure.

4 (1) Obtain an account and valid Digital Signature from Bid Express® to bid
5 electronically.

6 (2) Subarticle 103-2(B) will apply to Electronic Bidding.

7 (3) The bid shall be accompanied by an electronic bid bond or by a bid deposit. The bid
8 bond shall be completely and properly executed in accordance with Article 102-10.
9 The bid deposit shall be a certified check or cashier check in accordance with
10 Article 102-10.

11 (4) The bidder shall provide a Non-Collusion Affidavit, Debarment Certification and
12 Gift Ban Certification in accordance with Articles 102-2 and 102-9.

13 (5) All addenda and attachments will be considered part of the bid.

14 (6) All bids shall be submitted with an electronically affixed digital signature. Affixing
15 a digital ID to the bid shall be the equivalent of signing before a notary public.

16 (7) By submitting an electronic bid, the bidder certifies that he has read, understands,
17 accepts, acknowledges and agrees to comply with all statements, conditions and
18 specifications in the electronic bid submittal.

19 (8) Bids will be decrypted, opened, printed to paper and read publicly in accordance
20 with Article 102-13.

21 (9) The Contractor shall submit a fully executed Execution of Contract, signature sheet
22 and payment and performance bonds within 14 calendar days of receipt of award
23 letter in accordance with Article 102-9.

24 **102-9 NON-COLLUSION AFFIDAVIT, DEBARMENT CERTIFICATION AND** 25 **GIFT BAN CERTIFICATION**

26 (A) General

27 Prime Contractors and lower tier participants in each transaction involving public funds
28 shall execute a Non-Collusion Affidavit, Debarment Certification and Gift Ban
29 Certification. Transactions that require certifications from lower tier participants are:

30 (1) Transactions between a Prime Contractor and a person, other than for a procurement
31 contract, for goods or services, regardless of type.

32 (2) Procurement contracts for goods and services, between a prime contractor and
33 a person, regardless of type, expected to equal or exceed the Federal small purchase
34 threshold fixed at 10 U.S.C. 2304(g) as revised [currently \$100,000] under a prime
35 contract.

36 (3) Procurement contracts for goods or services between a prime contractor and
37 a person, regardless of the amount, under which that person will have a critical
38 influence on or substantive control over the transaction. Such persons include, but
39 are not limited to, bid estimators and contract managers.

40 The certifications for both the Prime Contractor and the lower tier participants shall be on
41 a form furnished by the Department to comply with Federal Highway Administration
42 requirements, as published in 49 CFR Part 29. The Prime Contractor is responsible for
43 obtaining the certifications from the lower tier participants and is responsible for keeping
44 them as part of the contract records.

(B) Non-Collusion Affidavit

In compliance with applicable Federal and State laws and regulations, each and every bidder shall furnish the Department with an affidavit certifying that the bidder has not entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with his bid on the project. The affidavit shall conclusively indicate that the bidder intends to do the work with its own bona fide employees or subcontractors and is not bidding for the benefit of another contractor.

(C) Debarment Certification

In compliance with applicable Federal and State laws and regulations, each and every bidder shall furnish the Department with a debarment certification, stating that he is not debarred, or if he is debarred, an explanation shall be included. The explanation will not necessarily result in denial of participation in a contract. Failure to furnish a certification or an explanation will be grounds for rejection of a bid. If the prequalified bidder's status changes, he shall immediately submit a new fully executed debarment certification with an explanation of the change.

Failure to have a fully executed Non-Collusion Affidavit, Debarment Certification and Gift Ban Certification on file in the Contractual Services Office before submitting bids will cause those bids to be non-responsive.

(1) Paper Bid

Execution of Bid, Non-Collusion Affidavit, Debarment Certification and Gift Ban Certification forms will be included in the proposal as part of the signature sheets. Execution of the signature sheets will constitute Execution of the Bid, Non-Collusion Affidavit, Debarment Certification and Gift Ban Certification. The signature sheets shall be notarized.

(2) Electronic Bids

The prequalified bidder shall have a fully executed Non-Collusion Affidavit, Debarment Certification and Gift Ban Certification on file in the Contractual Services Office before submitting his bid. Forms may be downloaded from the Department's website.

The bidder shall provide a Debarment Certification in the electronic bid submittal. If a bidder cannot provide the Debarment Certification required, he shall provide an explanation in the Bid Express® miscellaneous folder within the .ebs file.

Within 14 calendar days after notice of award is received by him, the successful bidder shall submit a fully executed Execution of Contract, Non-Collusion Affidavit, Debarment Certification and Gift Ban Certification signature sheet.

102-10 BID BOND OR BID DEPOSIT

Each bid shall be accompanied by a corporate bid bond or a bid deposit of a certified or cashier's check in the amount of at least 5% of the total amount bid for the contract. When a bid is secured by a bid deposit, the execution of a bid bond will not be required.

If the bidder has failed to meet all conditions of the bid bond and the Department has not received the amount due under the bid bond, the bidder may be disqualified from further bidding as provided in Article 102-15.

Section 102

1 No bid will be considered or accepted unless accompanied by one of the foregoing securities.
2 The bid bond shall be executed by a corporate surety licensed to do business in
3 North Carolina. The certified check or cashier's check shall be drawn on a bank or trust
4 company insured by the Federal Deposit Insurance Corporation. Both shall be made payable
5 to the Department of Transportation in an amount of at least 5% of the total amount bid for
6 the contract. The condition of the bid bond or bid deposit is: the Principal shall not withdraw
7 its bid within 60 days after the opening of same and, if the Department shall award a contract
8 to the Principal, the Principal shall, within 14 calendar days after the notice of award is
9 received by him, give payment and performance bonds with good and sufficient surety as
10 required for the faithful performance of the contract and for the protection of all persons
11 supplying labor and materials in the prosecution of the work. In the event of the failure of the
12 Principal to give such payment and performance bonds as required, then the amount of the bid
13 bond shall be immediately paid to the Department as liquidated damages, or, in the case of a
14 bid deposit, the deposit shall be forfeited to the Department.

15 Withdrawal of a bid due to a mistake made in the preparation of the bid, where permitted by
16 Article 103-3, shall not constitute withdrawal of a bid as cause for payment of the bid bond or
17 forfeiture of the bid deposit.

18 When a bid is secured by a bid bond, the bid bond shall be on the form furnished by the
19 Department. The bid bond shall be executed by both the bidder and a corporate surety
20 licensed under the laws of North Carolina to write such bonds. The execution by the bidder
21 shall be in the same manner as required by Article 102-8 for the proper execution of the bid.
22 The execution by the corporate surety shall be the same as is provided for by
23 Subarticle 102-8(A)(8)(b), for the execution of the bid by a corporation. The seal of the
24 corporate surety shall be affixed to the bid bond. The bid bond form furnished is for
25 execution of the corporate surety by a General Agent or Attorney in Fact. A certified copy of
26 the Power of Attorney shall be attached if the bid bond is executed by a General Agent or
27 Attorney in Fact. The Power of Attorney shall contain a certification that the Power of
28 Attorney is still in full force and effect as of the date of the execution of the bid bond by the
29 General Agent or Attorney in Fact. If the bid bond is executed by the corporate surety, the
30 President, Vice President or Assistant Vice President, and attested to by the Secretary or
31 Assistant Secretary, then the bid bond form furnished shall be modified for such execution,
32 instead of execution by the Attorney in Fact or the General Agent.

33 An electronic corporate surety bid bond for at least 5% of the total amount bid shall
34 accompany each electronic bid, or the Contractor may submit a certified check or cashier's
35 check instead of an electronic bid bond. The certified check or cashier's check shall be for at
36 least 5% of the total amount bid, shall be received by 5:00 p.m. the last business day before
37 the bid letting and shall be delivered to the Contract Officer at the address shown in the
38 Invitation to Bid.

39 Contact either or both of the following bond management companies to acquire the necessary
40 service to submit an electronic bid bond:

41 **(A) Surety 2000**

42 100 Terminal Dr., Plainview, NY 11803, 1-800-660-3263

43 **(B) Surepath (InSure Vision Technologies, LLC)**

44 5170 Sepulveda Blvd., Ste. 200, Sherman Oaks, CA 91403, 1-818-783-3460

45 **102-11 DELIVERY OF BIDS**

46 Paper Bids shall be delivered before the time and place specified in the contract. Bids
47 received after such time will not be accepted and will be returned to the bidder unopened.

48 Electronic Bids shall be submitted via approved Department electronic bidding software in
49 accordance with Article 102-8.

102-12 WITHDRAWAL OR REVISION OF BIDS**(A) Paper Bid**

A bidder may, without prejudice to himself, withdraw a paper bid after it has been delivered to the Department, provided the request for such withdrawal is made, in writing, to the Contract Officer before the date and time set for the opening of bids. The bidder may then submit a revised bid provided it is received before the time set for opening of bids.

Only those persons authorized to sign bids under the provisions of Subarticle 102-8(A)(8) shall be recognized as being qualified to withdraw a bid.

(B) Electronic Bid

An electronic bid may be changed and resubmitted as many times as desired before the advertised bid opening time specified in the Invitation to Bid. The latest time stamped electronically submitted bid before the advertised bid opening time will constitute the bid.

Withdrawal of a bid after the date and time set for the opening of bids will be permitted only in accordance with Article 103-3.

102-13 RECEIPT AND OPENING OF BIDS

A bid will be received and opened from any bidder who:

(A) Is prequalified in accordance with the provisions of Article 102-2 and

(B) Has delivered the bid to the place indicated in the contract before the time indicated in the Invitation to Bid.

(1) Paper Bids will be opened and read publicly at the time and place indicated in the Invitation to Bid.

(2) Electronic Bids will be decrypted, opened, printed to paper and read publicly at the time and place specified in the Invitation to Bid.

Bidders, their authorized agents and other interested parties are invited to be present.

A bid received from a bidder who has not complied with the above requirements will be returned to the Bidder unopened and under no circumstances will be considered for award.

In the event of technical difficulties or adverse weather conditions, the Department reserves the right to postpone the reading of bids past the advertised bid opening time and date.

102-14 REJECTION OF BIDS

Any bid submitted that fails to comply with any of the requirements of Articles 102-8, 102-9 and 102-10 shall be considered irregular and may be rejected.

Irregularities due to apparent clerical errors and omissions may be waived in accordance with Article 103-2.

Any bid including any unit or lump sum bid price that is unbalanced to the potential detriment of the Department will be considered irregular and may be rejected. In the event the Board determines it is in the best public interest to accept such irregular bid, it may award the contract based on such bid subject to Subarticle 109-4(C).

All bidders shall comply with all applicable laws regulating the practice of general contracting as contained in Chapter 87 of the General Statutes of North Carolina, except where waived by the Department by project special provision for certain specialty work. Bidders shall comply with all other applicable laws regulating the practices of electrical, plumbing, heating and air conditioning and refrigeration contracting as contained in Chapter 87 of the General Statutes of North Carolina.

Section 102

1 (A) State Funded Projects

2 The bidder shall be licensed by the North Carolina Licensing Board for General
3 Contractors where the bid is \$30,000 or more. Bids received from bidders not meeting
4 this requirement will be considered non-responsive and will not be considered for award.

5 (B) Federal Aid Projects

6 The bidder is not required to be licensed by the North Carolina Licensing Board for
7 General Contractors to place a bid of \$30,000 or more. However, a project may not be
8 awarded until the bidder provides evidence that the appropriate General Contractor
9 license has been obtained. The license shall be obtained within 60 days of bid opening or
10 the project may be awarded to another bidder or all bids rejected. No contract time
11 extension will be considered for delays associated with obtaining a license.

12 The right to reject any and all bids shall be reserved to the Department.

13 102-15 DISQUALIFICATION OF BIDDERS

14 Any one of the following causes may be justification for disqualifying a Contractor from
15 further bidding until he has applied for and has been requalified in accordance with
16 Article 102-2:

17 (A) Unsatisfactory progress in accordance with Article 108-8.

18 (B) Being declared in default in accordance with Article 108-9.

19 (C) Uncompleted contracts which, in the judgment of the Engineer, might hinder or prevent
20 the timely completion of additional work if awarded.

21 (D) Failure to comply with prequalification requirements.

22 (E) The submission of more than one bid for the same contract by individuals, partnerships,
23 joint ventures, LLCs or corporations whom the Department determines are under
24 sufficient common ownership and management control to warrant the firms be
25 considered a single entity.

26 (F) Evidence of collusion among bidders. Each participant in such collusion will be
27 disqualified.

28 (G) Failure to furnish a Non-Collusion Affidavit, Debarment Certification or Gift Ban
29 Certification upon request.

30 (H) Failure to comply with Article 108-6.

31 (I) Failure to comply with a written order of the Engineer as provided in Article 105-1, if in
32 the judgment of the Engineer, such failure is of sufficient magnitude to warrant
33 disqualification.

34 (J) Failure to satisfy the Disadvantaged Business Enterprise requirements of the project
35 special provisions.

36 (K) The Department has not received the amount due under a forfeited bid bond or under the
37 terms of a performance bond.

38 (L) Failure to submit the documents required by Article 109-10 within 60 days after request
39 by the Engineer.

40 (M) Failure to return overpayments as directed by the Engineer.

41 (N) Failure to maintain a satisfactory safety index as required by Article 102-2.

42 (O) Recruitment of Department employees for employment as prohibited by Article 108-5.

43 (P) False information submitted on any application, statement, certification, reports, records
44 or reproduction.

1 (Q) Conviction of any employee of the company, of any applicable state or federal law, may
2 be fully imputed to the business firm with which he is or was associated or by whom he
3 was employed or with the knowledge or approval of the business firm or there after
4 ratified by it.

5 (R) Being debarred from performing work with other Federal, State and city agencies.

6 (S) Failure to perform guaranty work within the terms of the contract.

7 (T) Failure to make prompt payment in accordance with Article 109-4.

8 Upon a determination that a contractor should be disqualified for one or more of the reasons
9 listed above, the Department may, at its discretion, remove all entities which are considered as
10 a single entity as described in Subarticle 102-15(E).

11 **SECTION 103**
12 **AWARD AND EXECUTION OF CONTRACT**

13 **103-1 CONSIDERATION OF BIDS**

14 After the bids are opened and read, they will be compared on the basis of the summation of
15 the products of the quantities shown in the bid schedule by the unit bid prices. The results of
16 such comparisons will be immediately available to the public. In the event of errors,
17 omissions, or discrepancies in the bid prices, corrections to the bid prices will be made in
18 accordance with Article 103-2. Such corrected bid prices will be used for the comparison and
19 consideration of bids.

20 The right is reserved to reject any or all bids, to waive technicalities, to request the low bidder
21 to submit an up-to-date financial and operating statement, to advertise for new bids or to
22 proceed to do the work otherwise, if in the judgment of the Department, the best interests of
23 the State will be promoted thereby.

24 **103-2 CORRECTION OF BID ERRORS**

25 The provisions of this article shall apply in waiving irregularities and correcting apparent
26 clerical errors and omissions in the unit bid price and the amount bid for bid items.

27 **(A) Paper Bid**

28 (1) Omitted Unit Bid Price--Amount Bid Completed--Quantity Bid on is One Unit

29 In the case of a bid item for which the amount bid is completed, but the unit bid price
30 is omitted and the quantity shown in the proposal for the bid item is only one unit,
31 the unit bid price shall be deemed to be the same as the amount bid for that bid item
32 and shall constitute the contract unit price for that bid item.

33 (2) Omitted Unit Bid Price--Amount Bid Completed--Quantity Bid on is More Than
34 One Unit

35 In the case of a bid item for which the amount bid is completed (extension of the unit
36 bid price by the quantity) but the unit bid price is omitted and the quantity shown in
37 the proposal for the bid item is more than one unit, the unit bid price shall be deemed
38 to be the amount derived by dividing the amount bid for that item by the quantity
39 shown in the proposal for that bid item and shall constitute the contract unit price for
40 that bid item.

Section 103

(3) Discrepancy in the Unit Bid Price and the Amount Bid

In the case of a bid item in which there is a discrepancy between the unit bid price and the extension for the bid item (amount bid), the unit bid price shall govern.

As an exception to the above, on bids for contracts not funded with any federal funds, the extension for the bid item (amount bid) shall govern when the discrepancy consists of an obvious clerical mistake in the unit bid price consisting of the misplacement of a decimal point. The correction to the unit bid price will be made only when the following two conditions are met:

(a) The corrected unit bid price multiplied by the quantity equals the amount bid for the bid item.

(b) The corrected unit bid price is closer to the average of the engineer's estimate and the individual bids for the contract item than the uncorrected unit bid price.

(4) Omitted Unit Bid Price and Omitted Amount Bid--Deemed Zero Bid

(a) State Funded Projects

In the case of omission of the unit bid price and the omission of the amount bid for any one item except Mobilization and, in the case of the omission of the amount bid where a lump sum price is called for, the amount bid and the unit bid price shall be deemed to be zero where the value of the omitted amount bid is 1% or less of the total amount bid for the entire project (excluding the omitted item). The value of the omitted amount bid will be derived by determining the average of the engineer's estimate and the individual bids for that contract item.

Where the unit bid price is deemed to be zero as provided in this subarticle, such zero unit bid price shall constitute the contract unit price for the affected bid item.

Where the amount bid for a lump sum bid item is deemed to be zero except Mobilization, as provided in this subarticle, such zero amount bid shall constitute the contract lump sum price for that bid item.

In the case of omission of the amount bid for Mobilization, the bid shall be deemed irregular and may be rejected.

(b) Federally Funded Projects

In the case of omission of the unit bid price and the omission of the amount bid for any one item and, in the case of the omission of the amount bid where a lump sum price is called for, the bid will be considered nonresponsive and will not be considered for award.

(5) Unit Bid Prices Containing More Than Four Decimal Places

In the case of a Bid Item for which the amount bid contains more than 4 decimal places for the Unit Bid Price, only the whole number and the first 4 decimal places shall constitute the Contract Unit Price for that Bid Item.

(B) Electronic Bids

(1) Enter a unit price in schedule of items. Totals will be generated automatically.

(2) Data incorrectly entered may not be recognized, and the bid item may remain blank until entered correctly.

(3) Enter no more than 4 decimal places for unit price.

- 1 (4) Do not enter zero (0) in any unit price field unless zero is the intended bid for that
 2 item. Zero will be considered a valid bid. However, where zeros are entered for
 3 items that are authorized alternates to those items for which a non-zero bid price has
 4 been submitted, zeros will be deemed invalid.
- 5 (5) When the proposal allows alternate bids, the bidder shall submit a unit or lump sum
 6 price for every item in the proposal other than items that are authorized alternates to
 7 those items for which a bid price has been submitted. Where the bidder submits
 8 a unit price other than zero for all items of an authorized alternate, the Department
 9 will determine the lowest total price based on the alternate bid.

10 **103-3 WITHDRAWAL OF BIDS--MISTAKE**

11 **(A) Criteria for Withdrawal of Bid**

12 The Department of Transportation may allow a bidder submitting a bid pursuant to
 13 NCGS § 136-28.1 for construction or repair work to withdraw his bid after the scheduled
 14 time of bid opening upon a determination that:

- 15 (1) A mistake was in fact made in the preparation of the bid.
- 16 (2) The mistake in the bid is of a clerical or mathematical nature and not one of bad
 17 judgment, carelessness in inspecting the work site or in reading the contract.
- 18 (3) The mistake is found to be made in good faith and was not deliberate or by reason of
 19 gross negligence.
- 20 (4) The amount of the error or mistake is equal to or greater than 3% of the total amount
 21 bid.
- 22 (5) The notice of mistake and request for withdrawal of the bid by reason of the mistake
 23 is communicated to the Engineer within 48 hours after the scheduled time of bid
 24 opening. Upon proper notification of a mistake and request for withdrawal of bid,
 25 the bidder shall submit within 48 hours written notice of mistake accompanied by
 26 copies of bid preparation information to the Engineer. The notification of a mistake,
 27 request for withdrawal of bid and copies of bid preparation information shall be
 28 submitted to the State Contract Officer or Engineer.
- 29 (6) The Department will not be prejudiced or damaged except for the loss of the bid.

30 **(B) Hearing by the Engineer**

31 If a bidder files a notice of mistake along with a request to withdraw his bid, the Engineer
 32 will promptly hold a hearing thereon. The Engineer will give to the requesting bidder
 33 reasonable notice of the time and place of any such hearing. The bidder may appear at
 34 the hearing and present the original working papers, documents or materials used in the
 35 preparation of the bid sought to be withdrawn, together with other facts and arguments in
 36 support of his request to withdraw his bid. The bidder shall be required to present
 37 a written affidavit that the documents presented are the original, unaltered documents
 38 used in the preparation of the bid.

39 **(C) Action by State Highway Administrator**

40 A determination may be made by the Administrator that the bidder meets the criteria for
 41 withdrawal of the bid as set forth in Subarticle 103-3(A) upon presentation of clear and
 42 convincing evidence by the bidder. The Engineer will present his findings to the State
 43 Highway Administrator for action on the bidder's request. The Engineer will advise the
 44 bidder of the Administrator's decision before the Department's consideration of award.

Section 103

1 (D) Bid Bond

2 If a bid mistake is made and a request to withdraw the bid is made, the bid bond shall
3 continue in full force and effect until there is a determination by the Administrator that
4 the conditions in Subarticle 103-3(A) have been met. The effect of the refusal of the
5 Contractor to give payment and performance bonds within 14 calendar days after the
6 notice of award is received by him, if award has been made by the Department after
7 consideration and denial of the Contractor's request to withdraw his bid, shall be
8 governed by the terms and conditions of the bid bond.

9 103-4 AWARD OF CONTRACT

10 (A) General

11 The North Carolina Department of Transportation, in accordance with the provisions of
12 Title VI of the Civil Rights Act of 1964 (78 Stat. 252) and the Regulations of the
13 Department of Transportation (49 CFR, Part 21), issued pursuant to such act, hereby
14 notifies all bidders that it will affirmatively insure that contracts entered in pursuant to
15 advertisements, if awarded, will be made by the Department to the lowest responsible
16 bidder without discrimination on the grounds of race, color or national origin. The lowest
17 responsible bidder will be notified by letter that his bid has been accepted and that he has
18 been awarded the contract. This letter shall constitute the notice of award. Where award
19 is to be made, the notice of award will be issued within 60 days after the opening of bids;
20 except with the consent of the lowest responsible bidder, the decision to award the
21 contract to such bidder may be delayed for as long a time as may be agreed upon by the
22 Department and such bidder. In the absence of such agreement, the lowest responsible
23 bidder may withdraw his bid at the expiration of the 60 days without penalty if no notice
24 of award has been issued.

25 Award of a contract involving any unbalanced bid price may be made in accordance with
26 Article 102-14.

27 (B) Award Limits

28 A bidder who desires to bid on more than one project on which bids are to be opened on
29 the same date and who desires to avoid receiving an award of more projects than he is
30 equipped to handle, may bid on any number of projects but may limit the total amount of
31 work awarded to him on selected projects by completing the form Award Limits on
32 Multiple Projects for each project subject to the award limit. In the event that a bidder is
33 the lowest responsible bidder on projects subject to the award limit and the value of such
34 projects is more than the award limit established by such bidder, the Department will not
35 award such bidder projects from among those subject to the award limit which have
36 a total value exceeding the award limit. The projects to be awarded to the bidder will be
37 those projects on which award will result in the lowest total cost to the Department.

38 In determining the lowest total cost to the Department, the options of rejecting a bid or
39 readvertising for new bids may be considered.

40 All bids submitted without the properly executed form Award Limits on Multiple
41 Projects will not be subject to the award limit. In the event that there is a discrepancy
42 between the completed award limit forms submitted by the same bidder for the different
43 projects in a letting, the Department reserves the right to declare all such award limit
44 forms invalid or to make such interpretation of the discrepancy as may be in the best
45 interests of the Department. However, the presence of such discrepancy shall not be
46 reason for declaring any bid irregular nor shall it invalidate the conditions of his bid bond
47 or bid deposit.

1 Where a prequalified Contractor bids individually (as opposed to a Joint Venture) on one
 2 or more projects and bids on one of more projects as part of a Joint Venture, such
 3 individual bidder and such Joint Venture will be considered separate bidders in applying
 4 the provisions of this article.

5 (1) Paper Bids

6 This form will be bound within each proposal. This form will not be effective unless
 7 the amount is filled in and the form is properly signed.

8 (2) Electronic Bids

9 This form is located in the .ebs miscellaneous data file of Expedite. The bidder shall
 10 click on yes or no to indicate whether or not the bidder desires to limit the award.

11 **103-5 CANCELLATION OF AWARD**

12 The Department reserves the right to rescind the award of any contract at any time before the
 13 receipt of the properly executed contract bonds from the successful bidder.

14 **103-6 RETURN OF BID BOND OR BID DEPOSIT**

15 Checks that have been furnished as a bid deposit by all bidders, other than the 3 lowest
 16 responsible bidders, will be retained not more than 10 calendar days after the date of opening
 17 of bids. After the expiration of such period, the checks that were furnished as a bid deposit
 18 will be returned to all bidders other than the 3 lowest responsible bidders.

19 Checks that have been furnished as a bid deposit by the 3 lowest responsible bidders will be
 20 retained until after the contract bonds have been furnished by the successful bidder at which
 21 time the checks that were furnished as a bid deposit will be returned to the 3 lowest
 22 responsible bidders.

23 Paper bid bonds will be retained by the Department until the contract bonds are furnished by
 24 the successful bidder after which all such bid bonds will be destroyed unless the individual
 25 bid bond form contains a note requesting that it be returned to the bidder or the Surety.

26 **103-7 CONTRACT BONDS**

27 The successful bidder, within 14 calendar days after the notice of award is received by him,
 28 shall provide the Department with a contract payment bond and a contract performance bond
 29 each in an amount equal to 100% of the amount of the contract. All bonds shall be in
 30 conformance with NCGS § 44A-33. The corporate surety furnishing the bonds shall be
 31 authorized to do business in the State.

32 **103-8 EXECUTION OF CONTRACT**

33 As soon as possible following receipt of the properly executed contract bonds, the Department
 34 will complete the execution of the contract, retain the original contract and return one certified
 35 copy of the contract to the Contractor.

36 **103-9 FAILURE TO FURNISH CONTRACT BONDS**

37 The successful bidder's failure to file acceptable bonds within 14 calendar days after the
 38 notice of award is received by him shall be just cause for the forfeiture of the bid bond or bid
 39 deposit and rescinding the award of the contract. Award may then be made to the next lowest
 40 responsible bidder or the work may be readvertised and constructed under contract or
 41 otherwise, as the Department may decide.

**SECTION 104
SCOPE OF WORK**

104-1 INTENT OF CONTRACT

The intent of the contract is to prescribe the work or improvements that the Contractor undertakes to perform, in full compliance with the contract documents. In case the method of construction or character of any part of the work is not covered by the plans, these specifications shall apply. The Contractor shall perform all work in accordance with the lines, grades, typical sections, dimensions and other data shown in the plans, or that may be modified by written orders and shall do such special, additional, extra and incidental work as may be considered necessary to complete the work to the full intent of the plans and specifications. Unless otherwise provided in the contract, the Contractor shall furnish all implements, machinery, equipment, tools, materials, supplies, transportation and labor necessary for the prosecution and completion of the work.

104-2 SUPPLEMENTAL AGREEMENTS

Whenever it is necessary to make amendments to the contract to satisfactorily complete the proposed construction or to provide authorized time extensions, the Engineer shall have the authority to enter into a supplemental agreement covering such amendments.

Supplemental agreements shall become a part of the contract when executed by the Engineer and an authorized representative of the Contractor. The Contractor shall file with the Engineer a copy of the name or names of his representatives who are authorized to sign supplemental agreements.

104-3 ALTERATIONS OF PLANS OR DETAILS OF CONSTRUCTION

The Engineer reserves the right to make, at any time during the progress of the work, such alterations in the plans or in the details of construction as may be found necessary or desirable. Under no circumstances will an alteration involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project. Such alterations shall not invalidate the contract nor release the Surety, and the Contractor agrees to perform the work as altered at his contract unit or lump sum prices the same as if it had been a part of the original contract except as otherwise herein provided.

An adjustment in the affected contract unit or lump sum prices due to alterations in the plans or details of construction that materially change the character of the work and the cost of performing the work will be made by the Engineer only as provided in this article.

If the Engineer makes an alteration in the plans or details of construction, which he determines will materially change the character of the work and the cost of performing the work, an adjustment will be made and the contract modified in writing accordingly. The Contractor will be paid for performing the affected work in accordance with Subarticle 104-8(A).

When the Contractor is required to perform work that is, in his opinion, an alteration in the plans or details of construction that materially changes the character of the work and the cost of performing the work, he shall notify the Engineer in writing before performing such work. The Engineer will investigate and, based upon his determination, one of the following will occur:

- (A) If the Engineer determines that the affected work is an alteration of the plans or details of construction that materially changes the character of the work and the cost of performing the work, the Contractor will be notified in writing by the Engineer and compensation will be made in accordance with Subarticle 104-8(A).

1 (B) If the Engineer determines that the work is not such an alteration in the plans or details of
 2 construction that materially changes the character of the work and the cost of performing
 3 the work, he will notify the Contractor in writing of his determination. If the Contractor,
 4 upon receipt of the Engineer's written determination, still intends to file a claim for
 5 additional compensation by reason of such alteration, he shall notify the Engineer in
 6 writing of such intent before beginning any of the alleged altered work, and the
 7 provisions of Subarticle 104-8(B) shall be strictly adhered to.

8 No contract adjustment will be allowed under this article for any effects caused on
 9 unaltered work.

10 If the Contractor elects to file a written claim or requests an extension of contract time, it shall
 11 be submitted on the Contractor Claim Submittal Form available through the Construction
 12 Unit.

13 **104-4 SUSPENSIONS OF WORK ORDERED BY THE ENGINEER**

14 **(A) Suspensions of the Work Ordered by the Engineer**

15 When the Engineer suspends in writing the performance of all or any portion of the work
 16 for a period of time not originally anticipated, customary or inherent to the construction
 17 industry and the Contractor believes that additional compensation for idle equipment or
 18 labor is justifiably due as a result of such suspension, the Contractor shall notify the
 19 Engineer in writing of his intent to file a claim for additional compensation within
 20 7 calendar days after the Engineer suspends the performance of the work and the
 21 provisions of Subarticle 104-8(C) shall be strictly adhered to.

22 Within 14 calendar days of receipt by the Contractor of the notice to resume work, the
 23 Contractor shall submit his claim to the Engineer in writing on the Contractor Claim
 24 Submittal Form available through the Construction Unit. Such claim shall set forth the
 25 reasons and support for such adjustment in compensation including cost records and any
 26 other supporting justification in accordance with Subarticle 104-8(C).

27 **(B) Alleged Suspension**

28 If the Contractor contends he has been prevented from performing all or any portion of
 29 the work for a period of time not originally anticipated, customary or inherent to the
 30 construction industry because of conditions beyond the control of and not the fault of the
 31 Contractor, its suppliers or subcontractors at any tier and not caused by weather, but the
 32 Engineer has not suspended the work in writing, the Contractor shall submit to the
 33 Engineer a written notice of intent to file a claim for additional compensation by reason
 34 of such alleged suspension. No adjustment in compensation will be allowed for idle
 35 equipment or labor before the time of the submission of the written notice of intent to file
 36 a claim for additional compensation by reason of such alleged suspension. Upon receipt,
 37 the Engineer will evaluate the Contractor's notice of intent to file a claim for additional
 38 compensation. If the Engineer agrees with the Contractor's contention, the Engineer will
 39 suspend in writing the performance of all or any portion of the work, and
 40 Subarticle 104-8(C) shall be strictly adhered to.

41 If the Engineer does not agree with the Contractor's contention as described above and
 42 determines that no portion of the work should be suspended, he will notify the Contractor
 43 in writing of his determination. If the Contractor does not agree with the Engineer's
 44 determination, Subarticle 104-8(C) shall be strictly adhered to. Within 14 calendar days
 45 after the last day of the alleged suspension, the Contractor shall submit his claim to the
 46 Engineer in writing on the Contractor Claim Submittal Form available through the
 47 Construction Unit. Such claim shall set forth the reasons and support for such adjustment
 48 in compensation, including cost records and any other supporting justification in
 49 accordance with Subarticle 104-8(C).

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1 (C) Conditions

2 No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B)
3 for any reason whatsoever for each occurrence of idle equipment or idle labor that has
4 a duration of 24 hours or less.

5 No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B)
6 to the extent that performance would have been suspended by any other cause or for that
7 an adjustment is provided for or excluded under any other term or condition of the
8 contract.

9 No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B)
10 for any effects caused on unchanged work. No adjustment in compensation will be
11 allowed under Subarticles 104-4(A) and 104-4(B) except for idle equipment or idle labor
12 resulting solely from the suspension of work in writing by the Engineer.

13 No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B)
14 where temporary suspensions of the work have been ordered by the Engineer in
15 accordance with Article 108-7 and the temporary suspensions are a result of the fault or
16 negligence of the Contractor.

17 **104-5 OVERRUNS AND UNDERRUNS OF CONTRACT QUANTITIES**

18 (A) General

19 The Engineer reserves the right to make at any time during the work such changes in
20 quantities as are necessary to satisfactorily complete the project. Such changes in
21 quantities shall not invalidate the contract, nor release the Surety, and the Contractor
22 agrees to perform the work as changed. The Engineer will notify the Contractor in
23 writing of the significant changes in the quantities.

24 The Contractor will be entitled to an adjustment in contract unit prices for increased costs
25 incurred over the original bid prices in performing contract items that overrun or
26 underrun the estimated contract quantities only as provided for in this article.

27 (B) Overruns - Increase in Unit Price

28 If the actual quantity of any major contract item overruns the original bid quantity by
29 more than 15% of such original bid quantity, or the actual quantity of any minor contract
30 item overruns the original bid quantity by more than 100% of such original bid quantity,
31 an increase to the contract unit price, excluding loss of anticipated profits, may be
32 authorized by the Engineer. Revised contract unit prices pertaining to overruns will be
33 applicable only to that portion of the overrun that is in excess of the percentages stated
34 above.

35 (1) Whenever it is anticipated that an overrun in a major or minor contract item in excess
36 of that described above will occur, the Contractor may make written request for
37 a revision to contract unit prices. It shall be incumbent upon the Contractor to justify
38 the request for a revision to contract unit prices. After reviewing the Contractor's
39 request, the Engineer will notify the Contractor of his determination as follows:

- 40 (a) If the Engineer determines a revision to the contract unit price is justified and
41 the Engineer and the Contractor are in agreement as to the revision to be made
42 to the contract unit price, a supplemental agreement covering the revised
43 contract unit price will be consummated before performing work on that
44 quantity in excess of the percentage set forth above.

1 If the Engineer determines a revision to the contract unit price is justified and
2 the Engineer and the Contractor are not in agreement as to the revision to be
3 made to the contract unit price, the Engineer will issue a force account notice
4 before performing work on that quantity in excess of the percentage set forth
5 above.

6 (b) If the Engineer determines a revision to the contract unit price is not justified he
7 will notify the Contractor of his determination in writing and payments will be
8 made for the work at the contract unit price. Upon completion of the work, the
9 Contractor may request an adjustment to the contract unit price as provided
10 below.

11 (2) Whenever an overrun in a contract item in excess of the percentages previously set
12 forth has occurred and a supplemental agreement establishing an increase to the
13 contract unit price has not been executed or the Engineer has not issued a force
14 account notice, the Contractor may make written request for a revision in the original
15 contract unit price. Any adjustment to the contract unit prices due to overruns will
16 be made by the Engineer based upon his evaluation and comparison of the
17 Contractor's documented cost records of the contract unit prices for those contract
18 items. The Contractor's documented cost records for the work performed on those
19 quantities beyond the percentages stated above shall be kept in accordance with
20 Article 109-3. The Contractor's cost records and supporting data shall be complete
21 in every respect and in such form that they can be checked. It shall be incumbent
22 upon the Contractor to satisfy the Engineer of the validity of any request presented
23 by the Contractor for an adjustment to the contract unit price. After reviewing the
24 Contractor's request, the Engineer can make such adjustment as he deems warranted
25 based upon his engineering judgment and the payment to the Contractor will be
26 made accordingly.

27 (C) Underruns - Increase in Unit Price

28 If the actual quantity of any major contract item underruns the original bid quantity by
29 more than 15% of such original bid quantity, an increase to the contract unit price,
30 excluding loss of anticipated profit, may be authorized by the Engineer. Revised contract
31 unit prices pertaining to underruns of major contract items will be applicable to the entire
32 quantity of the contract item that underruns. No revision will be made to the contract unit
33 price for any minor contract item that underruns the original bid quantities.

34 (1) Whenever it is anticipated that an underrun in a major contract item in excess of that
35 described above will occur, the Contractor may make written request for a revision
36 to the contract unit price. If the Engineer and the Contractor are in agreement as to
37 the revision to be made to the contract unit price, then a supplemental agreement
38 covering the revised unit price will be entered into. If the Engineer and the
39 Contractor are not in agreement, then after performance of the work, a revised unit
40 price may be determined as described below.

41 (2) Whenever an underrun in a major contract item in excess of the percentage
42 previously set forth has occurred and a supplemental agreement establishing
43 an increase to the contract unit price has not been executed, the Contractor may make
44 written request for a revision to the original contract unit price. The Contractor shall
45 submit sufficient documentation and analysis of his costs to satisfy the Engineer of
46 any non-recovered costs included in the item that underran. Any adjustment to the
47 contract unit prices due to underruns will be made by the Engineer based upon his
48 evaluation of the Contractor's documentation and an analysis showing how changes
49 in contract item cost are attributable to the underrun. An analysis of costs shall be
50 supplemented with the Contractor's documented cost records for work performed on
51 the total quantity of the affected item where the Contractor's request for
52 compensation includes compensation for costs other than recovered fixed costs.

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1 The Contractor's cost records shall be complete in every respect and in such form
2 that the Engineer can check them. It shall be incumbent upon the Contractor to
3 satisfy the Engineer of the validity of any request presented by the Contractor for
4 adjustment to the contract unit price. After reviewing the Contractor's request, the
5 Engineer may make such adjustment as he deems warranted, based upon his
6 engineering judgment and payment will be made on the final estimate. The total
7 payment, including any additional compensation granted by the Engineer due to an
8 underrun in a major contract item, shall not exceed the payment that would have
9 been made for the performance of 100% of the original contract quantity at the
10 original contract unit price.

11 Where non-stock fabricated materials are involved in minor items that underrun or in
12 major items that underrun by less than 15%, and where fabrication of such material
13 has begun or been completed before the Contractor is advised of the reduction in the
14 quantity of the pay item, the Department will reimburse the Contractor for the
15 verified fabrication cost, including the cost of material less salvage value, or it may
16 instruct the Contractor to have the fabricated material delivered to a site designated
17 by the Engineer and make payment for such material in accordance with
18 Article 109-6.

19 **(D) Overruns and Underruns - Reduction In Unit Price**

20 Whenever it is anticipated that an overrun or underrun in a major contract item in excess
21 of 15% or an overrun in a minor contract item in excess of 100% will occur, the Engineer
22 may make written request for a reduction to the contract unit price. If the Engineer and
23 the Contractor are in agreement as to the decrease to be made to the contract unit price,
24 a supplemental agreement covering the revised unit price will be consummated before
25 beginning work on that quantity in excess of the allowable percentages. If the Engineer
26 and the Contractor are not in agreement as to the decrease to be made, the Contractor will
27 be directed to perform the affected work on a force account basis. Payment for the
28 affected work will be made based upon force account records kept in accordance with
29 Article 109-3 but shall not exceed that payment that would have been made at the
30 original contract unit price.

31 **104-6 ELIMINATED CONTRACT ITEMS**

32 The Engineer may eliminate any item from the contract, and such action will in no way
33 invalidate the contract. In the event the item of work involves pre-fabricated materials that
34 are not considered to be stock items and fabrication of such material is begun or completed
35 before the Contractor is advised of the elimination of the contract item, the Department may
36 reimburse the Contractor for the verified fabrication cost including the cost of materials less
37 salvage value or may instruct the Contractor to have the fabricated material delivered to a site
38 designated by the Engineer and make payment for such material in accordance with
39 Article 109-6.

40 If the Contractor has partially completed a contract item before notification of the elimination
41 of such item, the Department will reimburse the Contractor for the verified actual cost of the
42 partially completed work not to exceed the payment that would have been made at the
43 contract unit or lump sum price for the completed work.

44 No payment will be made for loss of anticipated profits, and no other allowance will be made
45 for eliminated items except as listed above.

46 **104-7 EXTRA WORK**

47 The Contractor shall perform extra work whenever it is deemed necessary or desirable to
48 complete fully the work as contemplated. Extra work shall be performed in accordance with
49 the contract and as directed. No extra work shall be commenced before specific authorization
50 for the performance of such extra work being given by the Engineer.

1 Extra work that is specifically authorized by the Engineer will be paid in accordance with
2 Subarticle 104-8(A).

3 When the Contractor is required to perform work that is, in his opinion, extra work, he shall
4 notify the Engineer in writing before performing such work. The Engineer will investigate
5 and, based upon his determination, one of the following will occur.

6 (A) If the Engineer determines that the affected work is extra work, the Contractor will be
7 notified in writing by the Engineer and compensation will be made in accordance with
8 Subarticle 104-8(A).

9 (B) If the Engineer determines that the work is not extra work, he will notify the Contractor
10 in writing of his determination. If the Contractor upon receipt of the Engineer's written
11 determination intends to file a claim for additional compensation by reason of such work,
12 he shall notify the Engineer in writing of such intent before beginning any of the alleged
13 extra work and in conformance with Subarticle 104-8(B).

14 Work performed without prior written consent of the Engineer will be considered incidental to
15 the work of the contract.

16 If the Contractor elects to file a written claim or requests an extension of contract time, it shall
17 be submitted on the Contractor Claim Submittal Form available through the Construction
18 Unit.

19 **104-8 COMPENSATION AND RECORD KEEPING**

20 **(A) Compensation for Articles 104-3 or 104-7**

21 When the Engineer and Contractor agree that compensation is due under
22 Articles 104-3 or 104-7, payment will be made in accordance with one of the following:

23 (1) When the Engineer and the Contractor agree to the prices to be paid, the agreement
24 will be set forth in a supplemental agreement. If the estimated total cost of the
25 affected work is equal to or less than \$25,000 and the prices for performing the work
26 have been mutually agreed to, the Contractor may begin work before executing the
27 supplemental agreement. If the estimated total cost of the affected work is more than
28 \$25,000, the Contractor shall not begin the affected work until the supplemental
29 agreement is executed.

30 (2) When the Engineer and the Contractor cannot agree to the prices to be paid for the
31 affected work, the Engineer will issue a force account notice before the Contractor
32 beginning work. In this instance the affected work shall be performed as directed by
33 the Engineer and paid in accordance with Article 109-3.

34 **(B) Claim for Additional Compensation**

35 The Contractor's notice of intent to file a claim for additional compensation under
36 Articles 104-3 and 104-7 shall be given to the Engineer in writing. The Contractor shall
37 keep accurate and detailed cost records in accordance with Article 109-3. The
38 Contractor's cost records and supporting data shall be complete in every respect and in
39 such form that they may be checked by the Engineer. The Contractor's cost records and
40 supporting data shall clearly indicate the cost of performing the work in dispute and shall
41 separate the cost of any work for which payment has been made. The Contractor's cost
42 records shall be kept up to date and the Engineer shall be given the opportunity to review
43 the methods by which the records are being maintained. The cost records shall be
44 prepared weekly for each occurrence for which notice of intent to file a claim has been
45 given and submitted to the Engineer within 7 calendar days after the end of a given
46 weekly period.

Section 104

1 If the Contractor chooses to pursue the claim after the disputed work is complete, he shall
2 submit a written claim to the Engineer for an adjustment in compensation based upon his
3 cost records within 120 calendar days after completion of the disputed work. This claim
4 shall summarize previously submitted cost records and clearly describe the Contractor's
5 justification for an adjustment in compensation under the terms of the contract. The
6 claim shall be accompanied by a certification from an officer of the company or person
7 authorized to execute supplemental agreements, stating that the claim is truthful and
8 accurate.

9 Upon receipt, the Engineer will review the Contractor's request and supporting
10 documentation and notify the Contractor if the request is complete with all necessary
11 supporting documentation and cost records.

12 If the Engineer determines that the work covered by the claim is in fact compensable
13 under the terms of the contract, an adjustment in compensation will be made based upon
14 the documentation presented and his engineering judgment. The adjustment will be made
15 on the next partial pay estimate and reflected on the final estimate. The compensation
16 allowed shall be limited to the amount that would be paid if the work was performed in
17 accordance with Article 109-3.

18 If the Engineer determines that the work covered by the claim is not compensable under
19 the terms of the contract, the claim will be denied. The Engineer will notify the
20 Contractor of his determination whether or not an adjustment of the contract is warranted
21 within 120 calendar days after receipt of the complete request, all necessary supporting
22 justification and cost records.

23 The failure on the part of the Contractor to perform any of the following shall be a bar to
24 recovery under Articles 104-3 or 104-7:

- 25 (1) The failure to notify the Engineer in writing before performing the work in dispute
26 that he intends to file a claim.
- 27 (2) The failure of the Contractor to keep records in accordance with Article 109-3.
- 28 (3) The failure of the Contractor to give the Engineer the opportunity to monitor the
29 methods by which records are being maintained.
- 30 (4) The failure of the Contractor to submit additional documentation requested by the
31 Engineer provided documentation requested is available within the Contractor's
32 records.
- 33 (5) The failure of the Contractor to submit cost records weekly.
- 34 (6) The failure of the Contractor to submit the written request for an adjustment in
35 compensation with cost records and supporting information within 120 calendar days
36 of completion of the affected work.

(C) Compensation for Article 104-4

1 The Contractor's notice of intent to file a claim for additional compensation under
2 Subarticle 104-4(A) shall be given to the Engineer in writing within 7 calendar days after
3 the Engineer suspends the performance of the work. For an alleged suspension, the
4 Contractor's notice of intent to file a claim for additional compensation under
5 Subarticle 104-4(B) shall be given to the Engineer in writing. The Contractor shall keep
6 accurate and detailed records of the alleged idle equipment and alleged idle labor. The
7 Contractor's cost records, supporting data and supporting information shall be complete
8 in every respect and in such form that they may be checked by the Engineer. The
9 Contractor's cost records, supporting data and supporting information for equipment idled
10 due to the suspension or alleged suspension shall specifically identify each individual
11 piece of equipment, its involvement in the work, its location on the project, the requested
12 rental rate and justification as to why the equipment cannot be absorbed into unaffected
13 work on the project during the period of suspension or alleged suspension. The
14 Contractor's cost records, supporting data and supporting information for idle labor shall
15 include the specific employees, classification, dates and hours idled, hourly rate of pay,
16 their involvement in the project and justification as to why they cannot be absorbed into
17 the unaffected work on the project or other projects during the period of suspension or
18 alleged suspension. The Contractor's cost records, supporting data and supporting
19 information shall be kept up to date and the Engineer shall be given the opportunity to
20 review the methods by which the records, data and information are being maintained.
21 The cost records, supporting data and supporting information shall be prepared weekly
22 for each occurrence for which notice of intent to file a claim has been given and
23 submitted to the Engineer within 7 calendar days after the end of a given weekly period.
24

25 If the Contractor chooses to pursue the claim after the suspension or alleged suspension
26 period has ended, he shall submit a written claim to the Engineer for an adjustment in
27 compensation based upon his cost records due to idle equipment and/or idle labor within
28 14 calendar days of receipt of the notice to resume work or within 14 calendar days of
29 expiration of the alleged suspension period. This request shall summarize previously
30 submitted cost records and clearly describe the Contractor's justification for an
31 adjustment in compensation under the terms of the contract.

32 Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees
33 that the cost of the work directly associated with the suspension or alleged suspension has
34 increased as a result of such suspension or alleged suspension and the suspension or
35 alleged suspension was caused by conditions beyond the control of and not the fault of
36 the Contractor, his suppliers or subcontractors at any approved tier and not caused by
37 weather, the Engineer will make an adjustment, excluding profit, and will modify the
38 contract in writing accordingly. The Contractor will be paid the verified actual cost of
39 the idle equipment and idle labor. The compensation allowed shall be limited to the
40 equipment, labor, bond, insurance and tax costs, excluding profits, computed in
41 accordance with Article 109-3.

42 If the Engineer determines that the suspensions of the work by the Engineer or alleged
43 suspensions do not warrant an adjustment in compensation, he will notify the Contractor
44 in writing of his determination.

45 The Engineer will notify the Contractor of his determination of whether or not
46 an adjustment in compensation is warranted within 120 calendar days after receipt of the
47 complete request, all necessary supporting justification and cost records.

Section 104

1 The failure on the part of the Contractor to perform any of the following shall be a bar to
2 recovery under Article 104-4:

3 (1) The failure to notify the Engineer in writing within 7 calendar days after the
4 Engineer suspends in writing the performance of all or any portion of the work.

5 (2) The failure to notify the Engineer in writing that he intends to file a claim by reason
6 of alleged suspension.

7 (3) The failure of the Contractor to keep records in accordance with the details of
8 Article 109-3.

9 (4) The failure of the Contractor to give the Engineer the opportunity to monitor the
10 methods by which records are being maintained.

11 (5) The failure of the Contractor to submit additional documentation requested by the
12 Engineer provided the documentation requested is available within the Contractor's
13 records.

14 (6) The failure of the Contractor to submit cost records weekly.

15 (7) The failure of the Contractor to submit the written request for an adjustment in
16 compensation with cost records, supporting data and supporting information within
17 14 calendar days of receipt of the notice to resume work.

18 (8) The failure of the Contractor to submit the written request for an adjustment in
19 compensation with cost records, supporting data and supporting information within
20 14 calendar days after the last day of the period during which the Contractor
21 contends he has been prevented from performing all or any portion of the work for
22 an unreasonable period of time (not originally anticipated, customary, or inherent to
23 the construction industry) because of conditions beyond the control of, and not the
24 fault of, the Contractor, its suppliers or subcontractors at any approved tier and not
25 caused by weather.

26 **(D) Notification of Determination**

27 The failure on the part of the Engineer to notify the Contractor of his determination on
28 the requested adjustment in compensation within 120 calendar days after receipt of the
29 complete request, all supporting justification and cost records will result in payment of
30 interest on any monies determined to be due from the requested adjustment in
31 compensation. Interest, at the average rate earned by the State Treasurer on the
32 investment within the State's Short Term Investment Fund during the month preceding
33 the date interest becomes payable, will be paid to the Contractor on the next partial pay
34 estimate and reflected on the final estimate for the period beginning on the 121st day after
35 receipt of the complete request, all supporting justification and cost records, and
36 extending to the date the Engineer makes his determination on the disputed work.

37 If the Contractor fails to receive such adjustment in compensation for the disputed work
38 as he claims to be entitled to under the terms of the contract, the Contractor may resubmit
39 the written request for an adjustment in compensation to the Engineer as a part of the
40 final claim after the project is complete. The Contractor will only be allowed to submit
41 the request for an adjustment in compensation one time during the construction of the
42 project.

104-9 DISPOSITION OF SURPLUS PROPERTY

All property that is surplus to the needs of the project will remain or become the property of the Contractor, unless otherwise stated in the contract, with the following exceptions:

(A) Materials that are the property of utility companies providing service to buildings that are to be demolished or removed in accordance with Sections 210 and 215,

(B) Materials resulting from the removal of existing pavement in accordance with Section 250 that are to be stockpiled for the use of the Department,

(C) Materials resulting from the removal of existing structures in accordance with Section 402 where the contract indicates that the material will remain the property of the Department,

(D) Aggregate base course where the contract requires that this material become the property of the Department,

(E) Left over materials for which the Department has reimbursed the Contractor as provided in Article 109-6 and

(F) Materials that have been furnished by the Department for use on the project.

Property shall include but not be limited to materials furnished by the Contractor or the Department for either temporary or permanent use on the project, salvaged materials that were part of the existing facility on the date of availability for the project, and all implements, machinery, equipment, tools, supplies, laboratories, field offices and watercraft that are necessary for the satisfactory completion of the project.

All property that is the property of the Contractor shall be removed from the project by the Contractor before final acceptance.

104-10 MAINTENANCE OF THE PROJECT

The Contractor shall maintain the project from the date of availability or the date of beginning work, whichever occurs first, until the project is finally accepted. On resurfacing projects the Contractor shall maintain each part of the project, as defined by map numbers, from the date of beginning work on that part until such part is finally accepted. This maintenance shall be continuous and effective and shall be prosecuted with adequate equipment and forces to the end that all work covered by the contract is kept in satisfactory and acceptable condition at all times.

The Contractor shall maintain all existing drainage facilities, except where the work consists of resurfacing only, such that they are in the same condition upon acceptance of the project as they were when the project was made available to the Contractor.

In the event that the Contractor's work is suspended for any reason, the Contractor shall maintain the work covered by the contract, as provided herein.

When a portion of the project is accepted as provided in Article 105-17, immediately after such acceptance the Contractor will not be required to maintain the accepted portions. Should latent defects be discovered or become evident in an accepted portion of the project, such defective work shall be repaired or replaced at no cost to the Department.

Where an observation period is required that extends beyond the final acceptance date, the Contractor shall perform any work required by the observation period until satisfactory completion of the observation period. The Contractor will not be directly compensated for any maintenance operations necessary, as this work will be incidental to the work covered by the various contract items.

Section 104

1 **104-11 FINAL CLEANING UP**

2 Before acceptance of the project, the highway, borrow sources, waste areas and all ground
3 occupied by the Contractor within the project limits in connection with the work shall be
4 cleaned of all rubbish, excess materials, temporary structures and equipment. All parts of the
5 work shall be left in an acceptable condition.

6 The Contractor will not be directly compensated for the work of final cleaning up, as this
7 work will be considered incidental to the work covered by the various contract items.

8 **104-12 VALUE ENGINEERING PROPOSAL**

9 This value engineering specification is to provide an incentive to the Contractor to initiate,
10 develop and present to the Department for consideration, any cost reduction proposals
11 conceived by him involving changes to the contract. This specification does not apply unless
12 the proposal submitted is specifically identified by the Contractor as being presented for
13 consideration as a Value Engineering Proposal (VEP). Submittals that propose material
14 substitutions of permanent features, such as, but not limited to, changes from rigid to flexible
15 or flexible to rigid pavements, concrete to steel or steel to concrete bridges will not be
16 considered acceptable VEPs. Depending on the complexity of evaluation and
17 implementations, VEPs that provide for a total savings before distribution of less than
18 \$10,000 may not be considered.

19 **(A) Types of Proposals**

20 VEPs contemplated are those that would result in a net savings to the Department by
21 providing a decrease in the total cost of construction or reduce the construction time
22 without increasing the cost to construct the project. The effects the VEP may have on the
23 following items, but not limited to these items, will be considered by the Department
24 when evaluating the VEP:

- 25 (1) Service life,
- 26 (2) Safety,
- 27 (3) Reliability,
- 28 (4) Economy of operation,
- 29 (5) Ease of maintenance,
- 30 (6) Desired aesthetics,
- 31 (7) Design,
- 32 (8) Standardized features, and
- 33 (9) Environmental impact.

34 **(B) Evaluation of Proposals**

35 The Department reserves the right to reject the VEP or deduct from the savings identified
36 in the VEP to compensate for any adverse effects to these items that may result from
37 implementation of the VEP.

38 The Department reserves the right to reject, at its discretion, any VEP submitted that
39 would require additional right of way. Substitution of another design alternate detailed in
40 the contract plans for the one that the Contractor bid will not be allowed. Plan errors that
41 are identified by the Contractor and that result in a cost reduction will not qualify for
42 submittal as a VEP. Pending execution of a formal supplemental agreement
43 implementing an approved VEP, the Contractor shall remain obligated to perform in
44 accordance with the terms of the existing contract. No time extension will be granted due
45 to the time required to review a VEP.

(C) Subcontractors

The Contractor is encouraged to include this specification in contracts with subcontractors. The Contractor shall encourage submissions of VEPs from subcontractors; however, it is not mandatory that the Contractor accept or transmit to the Department, VEPs proposed by his subcontractors. The Contractor may choose any arrangement for the subcontractor value engineering payments, provided that these payments shall not reduce the Department's share of the savings resulting from the VEP.

(D) Preliminary Review

Should the Contractor desire a preliminary review of a possible VEP, before expending considerable time and expense in full development, a copy of the preliminary VEP shall be submitted to the Resident Engineer and the State Value Management Engineer in the Quality Enhancement Unit. The submittal shall state "Preliminary Value Engineering Proposal Review Request" and shall contain sufficient drawings, cost estimates and written information that can be clearly understood and interpreted. Include the identity of any Private Engineering Firms proposed by the Contractor to prepare designs or revisions to designs. The Department will review the preliminary submittal only to the extent necessary to determine if it has possible merit as a VEP. This review does not obligate the Department to approve the final VEP should a preliminary review indicate the VEP has possible merit. The Department is under no obligation to consider any VEP (Preliminary or Final) that is submitted.

(E) Final Proposal

A copy of the Final VEP shall be submitted by the Contractor to the Resident Engineer and the State Value Management Engineer in the Quality Enhancement Unit. The VEP shall contain, at a minimum, the following:

- (1) A statement that the request for the modification is being made as a VEP.
- (2) A description of the difference between the existing contract requirements and the proposed modifications, with the comparative advantages and disadvantages of each.
- (3) If applicable, a complete drawing of the details covering the proposed modifications and supporting design computations shall be included in the final submittal. The preparation of new designs or drawings shall be accomplished and sealed by an engineer licensed in the State of North Carolina. Further, the Department may require a review, and possibly the redesign, be accomplished by the project's original designer, or an approved equal. The Department may contract with private engineering firms, when needed, for reviews requested by the Department. The Contractor shall contract with the original project designer, or an approved equal, when required by the Department, for any design work needed to completely and accurately prepare contract drawings. The Department may waive the requirements to have the preparation of contract drawings accomplished by an engineer licensed in the State of North Carolina or the project's original design based on the extent, detail and complexity of the design needed to implement the proposal.
- (4) An itemized list of the contract requirements that would be modified and a recommendation of how to make each modification.
- (5) A detailed estimate of the cost of performing the work under the proposed modification.
- (6) A statement of the time when approval of the proposal shall be issued by the Department to obtain the total estimate cost reduction during the remainder of the contract, noting any effect on the contract completion or delivery schedule.

Section 104

(F) Modifications

To facilitate the preparation of revisions to contract drawings, the Contractor may purchase reproducible copies of drawings for his use through the Department's Value Engineering Office. The preparation of new design drawings by or for the Contractor shall be coordinated with appropriate Department Branch through the State Value Management Engineer in the Quality Enhancement Unit. The Contractor shall provide, at no charge to the Department, one set of reproducible drawings of the approved design needed to implement the VEP.

The Engineer will be the sole judge of the acceptability of a VEP requested in accordance with these requirements and of the estimated net savings resulting from the approval of all or any part of the VEP. The Contractor has the right to withdraw, in whole or in part, any VEP not accepted by the Department within the period to be specified in the VEP per Subarticle 104-12(E)(6).

If a VEP is approved, the necessary changes will be effected by supplemental agreement. Included as a part of the supplemental agreement will be requirements for price adjustment giving the Contractor 50% of the net savings to the project resulting from the modifications.

The Department reserves the right to include in the supplemental agreement any conditions it deems appropriate for consideration, approval and implementation of the VEP. Acceptance of the supplemental agreement by the Contractor shall constitute acceptance of such conditions.

The final net savings to be distributed will be the difference in cost between the existing contract cost for the involved unit bid items and actual final cost occurring as a result of the modification. Only those unit bid items directly affected by the supplemental agreement will be considered in making the final determination of net savings. In determining the estimated net savings, the Department reserves the right to disregard the contract prices if, in the judgment of the Department, such prices do not represent a fair measure of the value of the work to be performed or to be deleted. Subsequent change documents affecting the modified unit bid items, but not related to the VEP, will be excluded from such determination. The Department's review and administrative costs for VEPs will be borne by the Department. The Contractor's costs for designs and/or revisions to designs and the preparation of design drawings will be borne by the Contractor. The costs to either party will not be considered in determining the net savings obtained by implementing the VEP. The Contractor's portion of the net savings shall constitute full compensation to him for effecting all changes pursuant to the agreement. The net savings will be prorated, 50% to the Contractor and 50% to the Department, for all accepted VEPs.

Upon execution of the supplemental agreement, the Department will thereafter have the right to use, duplicate or disclose, in whole or in part, any data necessary for the use of the modification on other projects without obligation or compensation of any kind to the Contractor. Restrictions or conditions imposed by the Contractor for use of the VEP on other projects shall not be valid.

Except as may be otherwise precluded by this specification, the Contractor may submit a previously approved VEP on another project.

Unless and until a supplemental agreement is executed and issued by the Department, the Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract.

Acceptance of the modification and its implementation will not modify the completion date of the contract unless specifically provided for in the supplemental agreement.

1 The Contractor shall not be entitled to additional compensation under Section 104 for
2 alterations in the plans or in the details of construction pursuant to the VEP.

3 The Department will not be liable to the Contractor for failure to accept or act upon any
4 VEP nor for any delays to the work attributable to any such VEP.

5 The Department reserves the right to negotiate desired changes with the Contractor under
6 the requirements of the contract even though the changes are the result of a VEP
7 submitted on another contract. In this instance the savings will be prorated in accordance
8 with the terms of the negotiated agreement.

9 **104-13 RECYCLED PRODUCTS OR SOLID WASTE MATERIALS**

10 It is the policy of the Department to aid in reduction of materials that become a part of our
11 solid waste stream. To that extent the Department encourages contractors to initiate, develop
12 and use products and construction methods that incorporate the use of recycled or solid waste
13 products in the project. Recycled products or waste materials will be those products or
14 materials that would otherwise become solid waste and are collected, separated, or processed
15 and reused or returned to reuse in the form of raw materials or products that are incorporated
16 into a beneficial reuse on the project. Targeted materials include, but are not limited to, the
17 following: plastic, glass, paper, cardboard, shingles, tires, fly ash, bottom ash, sludge and
18 construction and demolition debris.

19 This Specification will not be applicable to reclaimed asphalt materials used in accordance
20 with Section 610 and shall not be applicable to any recycled or solid waste materials that are
21 specified for use by the Department on the project.

22 To use recycled or solid waste materials, the Contractor shall submit to the Department of
23 Transportation a Recycled Products or Solid Waste Materials Proposal for approval. This
24 proposal shall be submitted to the Resident Engineer and the State Value Management
25 Engineer in the Quality Enhancement Unit. The proposal shall contain, at a minimum,
26 a statement that the request for the modification is being made as a Recycled Products or
27 Solid Waste Materials proposal and the requirements in Subarticles 104-12(E)(2)
28 through 104-12(E)(6).

29 The Contractor shall be responsible for obtaining any and all permits that may be required for
30 the hauling, storing, or handling of the targeted materials.

31 If a Recycled Products or Solid Waste Materials proposal is approved, the necessary changes
32 will be effected by supplemental agreement. Included as a part of the supplemental
33 agreement will be requirements for price adjustment as follows:

34 **(A)** If the proposal results in a net savings to the Department the savings and distribution of
35 the savings shall be done in accordance with Article 104-12.

36 **(B)** If the proposal results in a net increase in the project cost but is judged to have
37 a significant effect on the development of long term markets for the targeted materials, or
38 results in significant beneficial usage of project generated debris that would have
39 otherwise been disposed of in accordance with Section 802, the Department will bear the
40 approved increased costs, if any. This includes recycled products that have been
41 approved by the Department but were not originally included in this contract.

42 **(C)** If the proposal is new and innovative, never used in the Department projects before as
43 approved by the Engineer and results in a net savings to the Department, the savings shall
44 be distributed in accordance with Article 104-12. However, when this innovative
45 proposal results in a net increase in project cost, Subarticle 104-13(B)(2) shall apply, and
46 at least \$500, but not more than \$2,500, may be awarded to the Contractor.

47 The Contractor shall provide certification that verifies the source of the material and the
48 percentage of targeted materials to be used.

Section 105

1 The Contractor shall remain obligated to perform the work in accordance with the terms of the
2 existing contract pending execution of the supplemental agreement that implements
3 an approved Recycled Products or Solid Waste Materials proposal and will not be entitled to
4 any additional compensation or additional contract time if a Recycled Products or Solid Waste
5 Materials proposal is not accepted.

6 The Department reserves the right to reject, at its discretion, any Recycled Products or Solid
7 Waste Materials proposal. The Engineer will be the sole judge of the acceptability, the value,
8 the estimated net savings and any additional compensation to be paid to the Contractor for all
9 or any part of the proposal.

10 Article 104-3 does not apply to a Recycled Products or Solid Waste Materials proposal.

11 Upon execution of the supplemental agreement, the Department will hereafter have the right
12 to use, duplicate or disclose in whole or in part any data necessary for use of the modification
13 on other projects without obligation or compensation of any kind to the Contractor.
14 Restrictions of conditions imposed by the Contractor for use of the proposal by the
15 Department on other projects shall not be valid.

16 The Department will not be liable to the Contractor for failure to accept or act upon any
17 Recycled Products or Waste Materials proposal submitted pursuant to this Specification, nor
18 for any delays to the work attributable to any third party claims, or fines that may be levied as
19 a result of the Contractor's decision to use targeted materials.

SECTION 105 CONTROL OF WORK

105-1 AUTHORITY OF THE ENGINEER

23 The Engineer will decide all questions that may arise as to the quality and acceptability of
24 materials furnished, work performed, rate of progress of the work; interpretation of the
25 contract; and fulfillment of the contract on the part of the Contractor. His decision shall be
26 final, and he shall have executive authority to enforce and make effective such decisions and
27 orders as the Contractor fails to carry out promptly.

28 The Engineer shall have the authority to issue any written order to the Contractor which he
29 considers necessary to the prosecution of the work and shall have executive authority to
30 enforce such written orders the Contractor fails to carry out promptly. Failure on the part of
31 the Contractor to comply with any written order issued by the Engineer may be justification
32 for disqualifying the Contractor from further bidding in accordance with Article 102-15.

105-2 PLANS AND WORKING DRAWINGS

34 Plans will show details of all structures, lines, grades, typical cross sections of the roadway,
35 location and design of all structures and a summary of items appearing in the proposal.

36 The plans shall be supplemented by such approved working drawings as are necessary to
37 adequately control the work. Working drawings furnished by the Contractor and approved by
38 the Engineer shall consist of such detailed drawings as may be required to adequately control
39 the work and are not included in the plans furnished by the Department. They may include
40 stress sheets, shop drawings, erection drawings, falsework drawings, cofferdam drawings,
41 bending diagrams for reinforcing steel, catalog cuts, or any other supplementary drawings or
42 similar data required of the Contractor. When working drawings are approved by the
43 Engineer, such approval shall not operate to relieve the Contractor of any of his responsibility
44 under the contract for the successful completion of the work.

1 Unless otherwise specified, the Contractor shall allow 40 calendar days for review and
2 approval, or acceptance, of working drawings from the date they are received until they are
3 returned by the Engineer, unless otherwise stated. If revised drawings are required,
4 appropriate additional time shall be allowed for review and approval, or acceptance, of the
5 revised drawings. The Contractor shall have no claim for extension of completion dates or
6 additional compensation due to this review period.

7 Changes on shop drawings after approval or distribution shall be subject to the approval of the
8 Engineer and he shall be furnished a record of such changes.

9 Payment at the contract prices will be full compensation for all costs of furnishing all working
10 drawings.

11 **105-3 CONFORMITY WITH PLANS AND SPECIFICATIONS**

12 All work performed and all materials furnished shall be in reasonably close conformity with
13 the lines, grades, cross sections, dimensions and material requirements, including tolerances,
14 shown in the contract.

15 In the event the Engineer finds the materials or the finished product in which the materials are
16 used not within reasonably close conformity with the contract but that reasonably acceptable
17 work has been produced, he will then make a determination if the work is to be accepted and
18 remain in place. If the Engineer determines that the work is to be accepted, he will have the
19 authority to make such adjustment in contract price as he deems warranted based upon his
20 engineering judgment and the final estimate will be paid accordingly.

21 In the event the Engineer finds the materials, or the finished product in which the materials
22 are used, or the work performed, are not in reasonably close conformity with the contract and
23 have resulted in an inferior or unsatisfactory product, the work or materials shall be removed
24 and replaced or otherwise corrected by the Contractor at no cost to the Department.

25 **105-4 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL 26 SPECIFICATIONS AND SPECIAL PROVISIONS**

27 The *Standard Specifications*, the Supplemental Specifications, the Plans, the Special
28 Provisions and all supplementary documents are essential parts of the contract, and
29 a requirement occurring in one is as binding as though occurring in all. They are
30 complimentary and provide and describe the complete contract. In case of discrepancy, the
31 following will apply in ascending order:

32 Calculated dimensions shall govern over scaled dimensions;

33 Supplemental Specifications shall govern over *Standard Specifications*;

34 Plans shall govern over Supplemental Specifications and *Standard Specifications*;

35 Standard Special Provisions shall govern over Plans, Supplemental Specifications and
36 *Standard Specifications*; and

37 Project Special Provisions shall govern over Standard Special Provisions, Plans,
38 Supplemental Specifications and *Standard Specifications*.

39 The Contractor shall not take advantage of any apparent error or omission in the contract. In
40 the event such errors or omissions are discovered the Engineer will make such corrections and
41 interpretations as may be determined necessary for the fulfillment of the intent of the contract.

Section 105

1 **105-5 COOPERATION BY CONTRACTOR**

2 The Contractor shall cooperate with the Engineer, his inspectors and other contractors in
3 every way possible and shall give the work the constant attention necessary to facilitate the
4 progress and satisfactory performance thereof. The Contractor shall notify the Engineer in
5 writing at least 7 calendar days before beginning work on the project. He shall notify the
6 Engineer at least 1 calendar day in advance when work is to be suspended and at least
7 2 calendar days in advance when work is to be resumed.

8 The Contractor shall keep available on the project site a copy of the entire contract at all
9 times.

10 **105-6 SUPERVISION BY CONTRACTOR**

11 **(A) On Site Personnel**

12 At all times that work is actually being performed, the Contractor shall have present on
13 the project one competent individual who has been authorized to act in a supervisory
14 capacity over all work on the project including work subcontracted. The individual who
15 has been so authorized shall be experienced in the type of work being performed and is to
16 be fully capable of managing, directing and coordinating the work, of reading and
17 thoroughly understanding the contract and of receiving and carrying out directions from
18 the Engineer or his authorized representatives. He shall be an employee of the Contractor
19 unless otherwise approved by the Engineer.

20 **(B) On Call Personnel**

21 At all times during the life of the project the Contractor shall provide one permanent
22 employee who shall have the authority and capability for the overall responsibility of the
23 project and who shall be personally available at the site of work within 24 hours notice.
24 Such employee shall be fully authorized to conduct all business with the subcontractors,
25 to negotiate and execute all supplemental agreements and to execute the orders or
26 directions of the Engineer.

27 **(C) Exceptions**

28 If the Contractor elects to have the employee described under Subarticle 105-6(B)
29 constantly available in person on the project, then the presence of this employee will be
30 considered as meeting Subarticle 105-6(A). However, whenever such employee is absent
31 from the project then an authorized individual meeting Subarticle 105-6(A) shall be
32 present on the project.

33 **105-7 COOPERATION BETWEEN CONTRACTORS**

34 The Department reserves the right at any time to contract for and perform other or additional
35 work on or near the work covered by the contract.

36 When separate or additional contracts are let within the limits of any one project, each
37 Contractor shall conduct his work so as not to interfere with or hinder the progress or
38 completion of the work being performed by other contractors. Contractors working within the
39 limits of the same project shall cooperate with each other.

40 Each Contractor shall conduct his operations in such a manner as to avoid damaging any work
41 being performed by others or that has been completed by others.

1 When a project is let under more than one contract and the plans or special provisions include
2 a construction schedule, it shall be the responsibility of the Contractors to complete the
3 various phases of the project in accordance with the time limits specified such that the total
4 contracts will be completed by the completion date. This construction schedule will remain in
5 effect until such time as the Contractors, at their option submit to the Engineer a joint
6 construction schedule meeting the approval of the Engineer. This joint construction schedule
7 shall be signed by authorized representatives of each firm and upon the approval of the
8 Engineer shall be binding on each firm. Subsequent modifications to the joint construction
9 schedule may be made during the course of the work in the same manner.

10 Failure of the Contractor to complete the various phases of work within the time limits set
11 forth in the construction schedule or latest approved joint construction schedule shall be just
12 cause for removing the Contractor from the Department's list of qualified bidders.
13 A Contractor disqualified from bidding by reason of this provision will not be reinstated until
14 such time as his progress is in accordance with the latest approved construction schedule or
15 until the project is completed and accepted, whichever occurs first.

16 The Department will under no circumstances be liable for any claim for additional
17 compensation due to acts of one contractor holding up the work of another.

18 The Department will under no circumstances be liable for any damages experienced by one
19 Contractor as a result of the presence and operations of other contractors working within the
20 limits of the same project.

21 **105-8 COOPERATION WITH UTILITY OWNERS**

22 Before the beginning of construction, the Department will notify all utility owners known to
23 have facilities affected by the construction of the project and will make arrangements for the
24 necessary adjustments of all affected public or private utility facilities. The utility
25 adjustments may be made either before or after the beginning of construction of the project.
26 The adjustments will be made by the utility owner or his representative or by the Contractor
27 when such adjustments are part of the work covered by his contract.

28 The Contractor shall use an independent utility locating service to locate utilities. The
29 Contractor shall use special care working in, around and near all existing utilities that are
30 encountered during construction, protecting them where necessary so that they will give
31 uninterrupted service.

32 The Contractor shall cooperate with the utility owner and/or the owner's representative in the
33 adjustment or placement of utility facilities when such adjustment or placement is made
34 necessary by the construction of the project or has been authorized by the Department.

35 In the event that utility services are interrupted by the Contractor, the Contractor shall
36 promptly notify the owners and shall cooperate with the owners and/or the owner's
37 representative in the restoration of service in the shortest time possible.

38 Existing fire hydrants shall be kept accessible to fire departments at all times.

39 Before submitting his bid, the Contractor shall make his own determination as to the nature
40 and extent of the utility facilities, including proposed adjustments, new facilities, or temporary
41 work to be performed by the utility owner or his representative; and as to whether or not any
42 utility work is planned by the owner in conjunction with the project construction. The
43 Contractor shall consider in his bid all of the permanent and temporary utility facilities in their
44 present or relocated positions, whether or not specifically shown in the plans or covered in the
45 project special provisions. It will be the Contractor's responsibility to anticipate any
46 additional costs to him resulting from such utility work and to reflect these costs in his bid for
47 the various items in the contract.

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1 No additional compensation, except as provided for in Article 104-4, will be allowed for
2 delays, inconvenience or damage sustained by the Contractor due to any interference from
3 said utility facilities or the operation of moving them, and any such delay, inconvenience or
4 damage, except as provided for in Article 104-4, shall not constitute a basis for a claim for
5 additional compensation.

6 Where changes to utility facilities are to be made solely for the convenience of the Contractor,
7 it shall be the Contractor's responsibility to arrange for such changes and the Contractor shall
8 bear all costs of such changes.

9 **105-9 CONSTRUCTION STAKES, LINES AND GRADES**

10 Unless otherwise required in the contract, the Engineer will set construction stakes
11 establishing lines, slopes and continuous profile-grade in road work, centerline and bench
12 marks for bridge work, culvert work, protective and accessory structures and appurtenances
13 that require the use of an engineer's level and transit, and will furnish the Contractor with all
14 necessary information relating to lines, slopes and grades. These stakes and marks shall
15 constitute the field control by, and in accordance with which, the Contractor shall establish
16 other necessary controls and perform the work.

17 The Contractor shall be held responsible for the preservation of all stakes and marks, and if
18 any of the construction stakes or marks have been carelessly or willfully destroyed or
19 disturbed by the Contractor, the cost of replacing them will be charged against him and will
20 be deducted from the payment for the work.

21 **105-10 AUTHORITY AND DUTIES OF THE INSPECTOR**

22 Inspectors employed by the Department are authorized to inspect all work performed and
23 materials furnished. Such inspection may extend to all or any part of the work and to the
24 preparation, fabrication, or manufacture of the materials to be used. The inspector is not
25 authorized to alter or waive the requirements of the contract. The inspector is not authorized
26 to issue instructions contrary to the contract, or to act as foreman for the Contractor; however,
27 he has the authority to reject work or materials until any questions at issue can be referred to
28 and decided by the Engineer. The inspector is not authorized to make any final acceptance of
29 the work.

30 **105-11 INSPECTION OF WORK**

31 All materials and each part or detail of the work shall be subject to inspection by the
32 Engineer. The Contractor shall allow and provide a reasonable access to all parts of the work
33 to the Engineer or his authorized representative. The Contractor shall furnish such
34 information and assistance as is required to make a complete and detailed inspection. Such
35 access shall meet the approval of the Engineer.

36 The presence of the Engineer or inspector at the work site shall in no way lessen the
37 Contractor's responsibility for conformity with the contract. Should the Engineer or
38 Inspector, before or during construction, fail to point out or reject materials or work that does
39 not conform with the contract, whether from lack of discovery or for any other reason, it shall
40 in no way prevent later rejection or corrections to the unsatisfactory materials or work when
41 discovered. The Contractor shall have no claim for losses suffered due to any necessary
42 removals or repairs resulting from the unsatisfactory work.

1 If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall
2 remove or uncover such portions of the finished work as may be directed. After examination,
3 the Contractor shall restore said portions of the work to the standard required by the
4 specifications. The Contractor shall keep cost records of the work performed and if the
5 uncovered work is found to be acceptable, the Department will pay the Contractor on a force
6 account basis in accordance with Article 109-3 for the cost of uncovering, or removing and
7 the replacing of the covering or making good of the parts removed; but should the work so
8 exposed or examined prove unacceptable, the uncovering or removing and the replacing of
9 the covering or making good of the parts removed, shall be at no cost to the Department.

10 When any other unit of government or political subdivision is to pay a portion of the cost of
11 the work covered by the contract, its respective representatives shall have the right to inspect
12 the work. When work is to be performed on the right of way of any railroad corporation or in
13 proximity to other public utilities, the representatives of the railroad corporation and/or the
14 public utilities shall have the right to inspect the work. Such inspection shall in no sense
15 make any unit of government or political subdivision or any railroad corporation or public
16 utility a party to the contract and shall in no way interfere with the rights of either party
17 thereunder.

18 **105-12 UNAUTHORIZED WORK**

19 No work shall be performed without established lines and grades except as otherwise
20 permitted by the Engineer. Work performed contrary to the instructions of the Engineer or
21 contrary to any approvals granted by the Engineer will be considered as unauthorized and
22 may not be paid under the requirements of the contract. Work performed beyond the lines
23 shown in the plans or as given, except as herein specified, or any extra work performed
24 without authority will be considered as unauthorized and may not be paid under the
25 requirements of the contract. Any of the above work so performed may be ordered removed,
26 replaced, or repaired at no cost to the Department.

27 Upon failure on the part of the Contractor to comply on time with any order of the Engineer
28 made under the provisions of this article, the Engineer will have the authority to cause such
29 unauthorized work to be removed or adjusted or both to conform to the contract and to deduct
30 the cost of removal or adjustment, or both, from any monies due or to become due the
31 Contractor.

32 **105-13 LIMITATIONS OF OPERATIONS**

33 At any time when, in the opinion of the Engineer, the Contractor has obstructed, closed, or is
34 conducting operations on a greater portion of the work than is necessary for the prosecution of
35 the work so as to constitute a hazard to the general public or impair the function of the facility
36 being constructed where traffic shall be maintained, the Engineer may require the Contractor
37 to suspend such unnecessary operations or closures and to finish the portions on which work
38 is in progress before starting work on additional portions of the work.

39 **105-14 NIGHT WORK**

40 Whenever the Contractor's operations are being conducted at night, the Contractor shall
41 provide such artificial lighting as may be necessary to provide for safe and proper
42 construction and to provide for adequate inspection of the work as described in Section 1413.

43 **105-15 RESTRICTION OF LOAD LIMITS**

44 The Contractor shall comply with all legal load restrictions in hauling equipment and
45 materials on roads under the jurisdiction of the Department.

Section 105

1 The Department has the right to place load limit restrictions on the load a Contractor may haul
2 on any road or bridge in the vicinity of his contract. The Contractor, before bidding on
3 a project, will be responsible for making his own investigations to determine the possibility of
4 load limit restrictions being placed on any of the highways he plans to use for hauling
5 purposes. The Contractor shall not be entitled to an extension of time or to compensation for
6 any costs, inconvenience, delay, or any other adversity to the Contractor as the result of any
7 reduction by the Department in load limit, or as the result of a refusal by the Department to
8 raise load limits as hereinafter provided or under any other conditions and any such reduction
9 in load limit or refusal to raise load limits shall not constitute a basis for a claim for additional
10 compensation.

11 Wherever load limit restrictions below the statutory legal load limit have been posted on any
12 roads and bridges on the project or within the vicinity of the project, the Department may
13 remove the load limit restrictions from such roads and bridges upon written request from the
14 Contractor, and the Contractor thereafter will be allowed to haul up to the statutory legal
15 limits over such roads and bridges, provided the Contractor enters into an agreement with the
16 Department providing for:

- 17 (A) Maintenance by the Contractor of such roads in a condition satisfactory to the Engineer
18 during the haul period.
- 19 (B) Repair by the Contractor of all damages to such roads after haul is completed to place
20 them in a condition as good as they were before removal of the load limits.
- 21 (C) Furnishing a bond by the Contractor in an amount determined by the Engineer for the
22 roads. Furnishing a bond for the roads does not entitle the Contractor to exceed the
23 posted load limits of any bridge.
- 24 (D) Assumption by the Contractor of all costs of strengthening any bridges that may be
25 necessary to safely haul loads up to statutory legal limits. The Department will, upon
26 request by the Contractor, make a determination as to the method and extent of
27 strengthening required for the bridges and will advise the Contractor as to the amount of
28 work to be done or an estimate of the charges for the work if performed by Department
29 forces. When Department forces perform the work, the Contractor shall reimburse the
30 Department in the amount of the actual charges for said work. When Contractor's forces
31 perform the work, it shall be done in accordance with plans approved by the Engineer and
32 under his inspection.
- 33 (E) Indemnification of the Department against any and all claims from third persons arising
34 out of or resulting from the hauling operation or the maintenance, or lack of maintenance,
35 of haul roads. Haul roads shall be maintained for the Contractor's hauling operations and
36 for the use of the general public.

37 Equipment operated on proposed bridges shall comply with load restrictions in Table 105-1.

TABLE 105-1	
RESTRICTIONS FOR EQUIPMENT ON BRIDGES	
Property	Maximum Load in Pounds
Axle load	36,000
Axle load on tandem axles	30,000
Gross load	90,000

38 The Contractor shall keep the bridge floor clean to reduce impact forces and place approved
39 temporary guides on the bridge floor to position the wheel loads as nearly as possible over the
40 bridge girders. Only one earth-moving vehicle shall be on a bridge at any time. Upon
41 completion of hauling over each bridge, the Contractor shall clean the bridge floor, curbs and
42 rails.

1 Regulations pertaining to size and weight will not apply to equipment used on the project
2 provided the vehicles involved are not operated on pavement, completed base course, or
3 structures.

4 **105-16 FAILURE TO MAINTAIN THE PROJECT OR PERFORM EROSION**
5 **CONTROL WORK**

6 Failure on the part of the Contractor to comply with Article 104-10 or to perform erosion
7 control work as directed will result in the Engineer notifying the Contractor to comply with
8 these Specifications. In the event that the Contractor fails to begin such remedial action or
9 fails to begin erosion control work within 24 hours after receipt of such notice with adequate
10 forces and equipment, the Engineer may proceed to have the work performed with other
11 forces. No payment will be made to the Contractor for work performed by others. Any costs
12 incurred by the Department for work performed by others as provided above in excess of the
13 costs that would have been incurred had the work been performed by the Contractor will be
14 deducted from monies due the Contractor on his contract.

15 **105-17 INSPECTION AND ACCEPTANCE**

16 Upon apparent completion of the entire project, the Engineer will inspect the project for final
17 acceptance. If all construction provided for and contemplated by the contract is found to be
18 satisfactorily completed, the project will be accepted. The acceptance of projects in their
19 entirety will not be altered except as listed below:

20 (A) When any continuous project is equal to or in excess of 5 miles in length, the Department
21 will accept the project in 2 increments with the first increment equaling at least 50% of
22 the total length of the project.

23 (B) Under resurfacing contracts, the Department will accept the project in parts as defined by
24 map numbers representing at least 25% of the total length of project.

25 (C) When it is considered to be in the best interest of the Department, other increments or
26 parts of projects may be considered for acceptance.

27 (D) When the contract contains an intermediate completion date requiring the completion of
28 a portion of the work in its entirety, such portion of the work may be accepted if
29 requested in writing by the Contractor.

30 (E) Bridge decks and rails that have been constructed or rehabilitated at such time as when
31 they are open to public traffic.

32 (F) Permanent sign panels, including hardware and retroreflective sheeting, that are located
33 where the roadway is open to public traffic and that are required to be installed before the
34 final acceptance of the project.

35 Acceptance of any increment or part of a project shall not operate to waive the assessment of
36 all or any portion of liquidated damages assessable under the terms of the contract.

37 When the inspection discloses any work, in whole or in part, as being unsatisfactory or
38 incomplete, the Engineer will advise the Contractor of such unsatisfactory or incomplete
39 work, and the Contractor shall immediately correct, repair or complete such work. The
40 project will not be accepted and the Contractor shall be responsible for the maintenance of the
41 project and maintenance of traffic until all of the recommendations made at the time of the
42 inspection have been satisfactorily completed.

43 The Engineer will notify the Contractor in writing that the project has been accepted as soon
44 as practicable after the completion of the project. When an observation period is required that
45 extends beyond the final acceptance date, the satisfactory completion of the observation
46 period shall be covered by the contract bonds.

**SECTION 106
CONTROL OF MATERIAL**

106-1 GENERAL REQUIREMENTS

(A) General

The materials used in the work shall meet all requirements of the contract and shall be subject to inspection, test, or rejection by the Engineer at any time. Materials used in the work shall be new, recycled, or recovered as permitted by the contract.

It is the Department's intent to expand the use of recyclable and recovered materials in its construction programs. The Contractor is encouraged to find innovative and alternative ways for beneficial use of recyclable materials that are currently a part of the solid waste stream and that contribute to problems of declining space in landfills.

The Contractor shall make his own determination of the various kinds and quantities of materials that are necessary for the acceptable performance and timely completion of the work. It shall be the Contractor's responsibility to obtain materials that meet the requirements of the contract. The Contractor shall be responsible for the acceptability of all materials used in the work and for the timely delivery of materials to the project so that adequate time will be available for the safe and proper performance of the work.

To facilitate testing by the Department, the Contractor shall furnish a complete statement of the origin of all materials to be used in the construction of the work, together with samples when required. The statement of origin shall be furnished to the Materials and Tests Unit sufficiently in advance of any shipment or fabrication of materials so that arrangements can be made for proper inspection.

The Contractor shall furnish a MSDS with all paints and hazardous chemicals proposed for use on the project. The MSDS shall be in accordance with the North Carolina Hazard Communication Standard, 13 NCAC 7CF.0101.(a)(99).

The Contractor shall provide access, means and assistance in the verification of all testing equipment, scales, measures and other devices operated by him in connection with the testing of the materials.

If the Contractor desires or is required to furnish materials from local deposits, other than those, if any, described in the contract, he shall assume full responsibility for the sampling of the sources and the acceptability of the material in accordance with these specifications. He shall furnish without charge such preliminary samples as may be required; except that, if requested in writing, the Engineer may allow Department forces to take samples as requested by the Contractor. In the latter case, the Contractor shall reimburse the Department for the total expense of the sampling as determined by the Engineer. Tests will be made and reports rendered, but it is understood that such tests shall in no way be construed as a guarantee of acceptance of any material that may be delivered later for incorporation in the work. The Contractor shall assume full responsibility for the production of uniform and satisfactory materials from such local deposits and shall indemnify and save harmless the Department from any and all claims for loss or damages resulting from the opening and operation thereof, or from the failure of the deposit after development to produce materials acceptable to the Engineer, in either quality or quantity.

(B) Domestic Steel

All steel and iron products that are permanently incorporated into this project shall be produced in the United States except minimal amounts of foreign steel and iron products may be used provided the combined project cost of the bid items involved does not exceed 0.1% of the total amount bid for the entire project or \$2,500, whichever is greater. This minimal amount of foreign produced steel and iron products permitted for use is not applicable to fasteners. Domestically produced fasteners are required.

All steel and iron products furnished as domestic products shall be melted, cast, formed, shaped, drawn, extruded, forged, fabricated, produced, or otherwise processed and manufactured in the United States. Raw materials including pig iron and processed pelletized and reduced iron ore used in manufacturing domestic steel products may be imported; however, all manufacturing processes to produce the products, including coatings, shall occur in the United States.

Before each steel or iron product is incorporated into any project or included for partial payment on a monthly estimate, the Contractor shall furnish the Engineer a notarized certification certifying that the product conforms to the above. The Engineer will forward a copy of each certification to the Materials and Tests Unit.

Each purchase order issued by the Contractor or a subcontractor for steel and iron products to be permanently incorporated into any project shall contain in bold print a statement advising the supplier that all manufacturing processes to produce the steel or iron shall have occurred in the United States. The Contractor and all affected subcontractors shall maintain a separate file for steel products permanently incorporated into any project so that verification of the Contractor's efforts to purchase domestic steel and iron products can readily be verified by an authorized representative of the Department or the Federal Highway Administration.

106-2 SAMPLES, TESTS AND CITED SPECIFICATIONS

All tests will be made in accordance with the most recent standard or interim methods of the AASHTO in force on the date of advertisement. Should no AASHTO method of test exist for a material, the most recent standard or tentative method of ASTM or other methods adopted by the Department will be used.

All reference made to a specification published by AASHTO, ASTM or any other organization other than the Department, that does not indicate the date of publication, will be understood to mean the specification current on the date of advertisement for the project. When a more current specification is published during the life of the project, and when it is mutually agreed by the Contractor and the Engineer and such agreement is documented by a supplemental agreement, the Department may accept materials meeting the requirements of the latest publication.

106-3 CONTRACTOR FURNISHED CERTIFICATION

The Contractor shall furnish the Department material certifications obtained from the producer, supplier or an approved independent testing laboratory for the following types of materials, unless otherwise directed by the Engineer:

- (A) Materials required to meet criteria documented by tests that are normally performed during the production process;
- (B) Materials that are required to meet specifications other than those published by AASHTO, ASTM or the Department;
- (C) Materials produced at locations that are not within routine travel distance for Department representatives;

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1 (D) Materials required to meet criteria documented by tests involving special equipment not
2 readily available to Department representatives; and

3 (E) Any other special material when so directed by the Engineer.

4 Material certifications of one of the following types shall be furnished for pre-tested
5 materials. The specific type of material certification for each material shall be in accordance
6 with the schedule maintained by the Materials and Tests Unit. Copies of this schedule may be
7 obtained from the Materials and Tests Unit.

8 **Type 1 - Certified Mill Test Report**

9 A certified mill test report shall be a certified report of tests conducted by the manufacturer on
10 samples taken from the same heat or lot number as the material actually shipped to the
11 project. The report shall identify the heat or lot number.

12 **Type 2 - Typical Certified Mill Test Report**

13 A typical certified mill test report shall be a certified report of tests conducted by the
14 manufacturer on samples taken from a lot that is typical of the material actually shipped to the
15 project, but that may or may not be from the lot shipped.

16 **Type 3 - Manufacturer's Certification**

17 A manufacturer's certification shall be a certified statement that the material actually shipped
18 to the project was manufactured by production processes that are periodically and routinely
19 inspected to assure conformance to specification requirements.

20 **Type 4 - Certified Test Reports**

21 A certified test report shall be a certified report of test conducted by an approved independent
22 testing laboratory on samples taken from the same heat or lot number as the material actually
23 shipped to the project. The report shall identify the heat or lot number.

24 **Type 5 - Typical Certified Test Reports**

25 A certified test report shall be a certified report of tests conducted by an approved
26 independent testing laboratory on samples taken from a lot that is typical of the material
27 actually shipped to the project, but that may or may not be from the lot shipped.

28 **Type 6 - Supplier's Certification**

29 A supplier's certification is a signed statement by the supplier that the material described in
30 the certification is of the specification grade required and that the supplier has on hand Type 1
31 or Type 2 material certifications to cover the material that is included in the Type 6 supplier's
32 certification.

33 **Type 7 - Contractor's Certification**

34 Contractor's certification is a signed statement by a contractor that the used material described
35 in the certification meets the current specifications to the best of the contractor's knowledge
36 and that the contractor had in his possession at the time of purchase a Type 1
37 or Type 2 material certification to cover the material that is included in the
38 Type 7 Contractor's certification.

39 **106-4 DELIVERY AND HANDLING OF MATERIALS**

40 All materials shall be handled carefully and in such manner as to preserve their quality and
41 fitness for the work. Materials damaged during delivery or handling shall not be used without
42 approval of the Engineer.

106-5 STORAGE OF MATERIALS

Materials shall be stored so as to insure the preservation of their quality and fitness for the work. Stored materials that may have been approved before storage shall be subject to inspection at any time and shall meet the specifications at the time it is put into use. Stored materials shall be located to facilitate their inspection. Subject to the approval of the Engineer, that portion of the right of way not required for public travel may be used for storage purposes and for the Contractor's plant and equipment, but any additional space required therefor shall be provided by the Contractor at no expense to the Department. All storage sites located within the right of way shall be restored to their original condition by the Contractor at no expense to the Department, except where the materials stored are or are to become the property of the Department.

106-6 INSPECTION AT SOURCE

The Engineer may undertake the inspection of materials at the source of supply. This inspection will be performed by Department personnel or private organizations retained by the Department. Where approved by the Engineer, the results of tests performed by private laboratories, producers, or manufacturer's laboratories may be used in determining compliance of a material or product with the specifications.

The Department assumes no obligation to inspect materials at the source of supply. Such inspection will be undertaken only upon condition that:

(A) The cooperation and assistance of the Contractor and the producer with whom he has contracted for materials is assured.

(B) The representative of the Engineer will have full entry authority at all times to such parts of the plant as may concern the manufacture or production of the materials.

(C) Laboratory facilities shall be provided when required by the Engineer.

Where the Department agrees to inspect or test materials during their production or at the source of supply, the Contractor shall bear the cost of testing performed on materials ordered by him but not incorporated into the project.

The Department reserves the right to retest all materials that have been tested and accepted at the source of supply after the same have been delivered and to reject all materials that, when retested, do not meet the specifications.

106-7 SCALES AND PUBLIC WEIGHMASTER

When material is to be paid on a per ton basis, the Contractor shall furnish platform scales or other weighing devices that have been certified by the N.C. Department of Agriculture. If the platform scales or other weighing devices are located outside of North Carolina, they shall have been certified by the Department of Agriculture within the particular state. The scales may be constructed and operated to provide automatic weighing, recording and printing of tickets for the load being weighed.

The Department may deny or withhold any portion of payment for any load of materials weighed if in relation to such load of materials, the Contractor falsifies any weighing certification information or otherwise fails to comply with the requirements contained in this contract.

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1 All scales shall be operated by a public weighmaster licensed in accordance with
2 NCGS § 81A. A certified weight certificate shall be issued by a North Carolina public
3 weighmaster for each load. The certificate shall be in the form of a ticket furnished by the
4 Contractor and shall contain the following information:

- 5 (A) Department project contract number
- 6 (B) Date
- 7 (C) Time issued, if for bituminous plant mix or Portland cement stabilized base course mixed
8 in a central plant
- 9 (D) Type of material
- 10 (E) Gross weight
- 11 (F) Tare weight
- 12 (G) Net weight of material
- 13 (H) Quarry or plant location
- 14 (I) Department's Job Mix Formula Number, if ticket is for asphalt plant mix
- 15 (J) Department's Asphalt Plant Certification Number, if ticket is for asphalt plant mix
- 16 (K) Truck number
- 17 (L) Contractor's name
- 18 (M) Public weighmaster's stamp or number
- 19 (N) Public weighmaster's signature or initials

20 When certified weighing devices other than platform scales are to be used, the gross weight
21 and tare weight will not be required.

22 The Engineer may direct the Contractor to re-weigh the contents of any truck load that is to be
23 delivered to the work on approved platform scales at no cost to the Department.

24 When tractor and trailer units are to be used in hauling material to be weighed, the platform
25 scales shall be of sufficient length so as to accommodate the entire unit or the tractor shall be
26 disconnected and the trailer and its contents weighed as a separate unit.

27 **106-8 DEPARTMENT FURNISHED MATERIAL**

28 The Contractor shall furnish all materials necessary to complete the work, except those
29 materials specified in the contract to be furnished by the Department. Payment at the contract
30 price for the item that includes the use of Department furnished material will be full
31 compensation for all costs of handling and placing such materials after they are delivered or
32 made available to the Contractor.

33 The Contractor shall be held responsible for all material furnished to him, and deductions will
34 be made from any money due him to make good any shortage and deficiencies from any
35 cause whatsoever and for any damage that may occur after Department furnished material has
36 been made available.

37 **106-9 DEFECTIVE MATERIAL**

38 All materials that are not in conformity to the contract shall be defective and such materials,
39 whether in place or not, may be rejected and removed from the site of the work unless
40 otherwise permitted by the Engineer in accordance with Article 105-3. No rejected material,
41 the defects of which may have been substantially corrected, may be used until approval has
42 been given by the Engineer.

43 **106-10 DENSITY DETERMINATION BY NUCLEAR METHODS**

44 The Engineer may, at his option, use nuclear methods as described in
45 Articles 520-9 and 610-10 to determine the density of selected pavement materials. The use
46 of nuclear methods will include the establishment of the required density through the use of
47 control strips constructed from materials actually being used on the project, and the
48 determination of the density being obtained in test sections located throughout the project.

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1 107-4 PATENTED DEVICES, MATERIALS AND PROCESSES

2 If the Contractor employs any design, device, material, or process covered by letters of patent
3 or copyright, he shall provide for such use by suitable legal agreement with the patentee or
4 owner. The Contractor and his Surety shall indemnify and save harmless the Department
5 from any and all claims for infringement by reason of the use of such patented design, device,
6 material, process, trademark or copyright and shall indemnify and save harmless the
7 Department from any costs, expenses and damages which it may be obligated to pay at any
8 time during the prosecution or after the completion of the work by reason of any alleged
9 infringement.

10 107-5 ENCROACHMENT ON RIGHT OF WAY

11 Any entity wishing to encroach on highway right of way shall secure a written permit from
12 the Department. The Contractor is not authorized to allow any entity to perform any work
13 within the limits of the project unless such work has been authorized in writing by the
14 Engineer.

15 When so directed by the Engineer, the Contractor shall make any repairs necessary due to
16 such encroachments and such work will be paid as extra work.

17 107-6 FEDERAL PARTICIPATION

18 When the United States Government pays all or any portion of the cost of the work, the
19 Federal laws authorizing such participation and the rules and regulations made pursuant to
20 such laws shall be observed by the Contractor. The work will be subject to the inspection of
21 the representative of such Federal agencies as are created for the administration of these laws.
22 The Contractor shall have no right to make the Federal Government a party to any court
23 action solely by reason of its participation in the cost of the work or by reason of its
24 inspection of the work.

25 107-7 SANITARY PROVISIONS

26 The Contractor shall provide and maintain in a neat, sanitary condition such accommodations
27 for the use of employees as may be necessary to comply with the requirements of the State
28 and local Boards of Health, or of other bodies or tribunals having jurisdiction. Control and
29 manage disposal of sanitary waste such that no adverse impacts occur to water quality.

30 107-8 PUBLIC CONVENIENCE AND SAFETY

31 The Contractor shall at all times conduct his work as to insure the least possible obstruction to
32 traffic. The safety and convenience of the general public and the residents along the highway,
33 and the protection of persons and property, shall be provided for by the Contractor as
34 specified in Section 150.

35 107-9 COORDINATION WITH RAILWAY

36 All work to be performed by the Contractor on railway right of way shall be performed in
37 accordance with the contract and in a manner satisfactory to the railway company and shall be
38 performed at such times and in such manner as not to unnecessarily interfere with the
39 movement of traffic upon the track of the railway company. The Contractor shall use all care
40 and precautions to avoid accidents, damage, or unnecessary delays or interference with the
41 railway company's traffic or other property. The Contractor shall carry such railroad
42 protective insurance and public liability and property damage insurance as may be stipulated
43 in the contract. The Department shall not be responsible for any damage or injury to the
44 railway company's traffic or property caused by the Contractor.

1 When the Contractor is required by the contract to transport materials or equipment across the
2 tracks of any railway or to perform work on railway right of way, the Department will obtain
3 any necessary written authority from the railway company for the establishment of a railway
4 crossing or for the performance of work on railway right of way. The Contractor will not be
5 required to bear the cost of any watchman service or flagging protection necessary due to such
6 operations, as the railway company will be reimbursed directly by the Department for the cost
7 of such work.

8 In case the Contractor elects or finds it necessary to transport materials or equipment across
9 the tracks of any railway at any point where a crossing is not required by the contract or at any
10 point other than an existing public crossing, he shall obtain specific written authority from the
11 railway company for the establishment of a private railway crossing and shall bear all costs in
12 connection with such crossing, including installation, drainage, maintenance, any necessary
13 insurance, watchman service, flagging protection and removal of such private railway
14 crossing.

15 **107-10 WORK IN, OVER OR ADJACENT TO NAVIGABLE WATERS**

16 All work in or over navigable waters shall be in accordance with conditions contained in the
17 permit obtained by the Department from the authority granting the permit. These conditions
18 will be included in the contract. The work shall be performed in such manner so as not to
19 interfere with navigation of the waterways unless approval therefor is obtained from the
20 authority granting the permit. The Department shall not be responsible for any damage or
21 injury to entities upon or adjacent to navigable waters caused by the Contractor.

22 The Contractor shall prepare drawings necessary to obtain any addenda that may be required
23 for his operations that are not included in the Department's permit. He shall coordinate their
24 submission with the Engineer.

25 **107-11 PROTECTION AND RESTORATION OF PROPERTY**

26 The Contractor shall be responsible for the protection from his activities of all public and
27 private property on and adjacent to the work and shall use every reasonable precaution
28 necessary to prevent damage or injury thereto. He shall use suitable precautions to prevent
29 damage to pipes, conduits and other underground structures and to poles, wires, cables and
30 other overhead structures.

31 The Contractor shall protect carefully from disturbance or damage all land monuments and
32 property markers until the Engineer has witnessed or otherwise referenced their location and
33 shall not remove them until directed.

34 The Contractor shall be responsible for the removal, preservation and resetting of all
35 mailboxes disturbed by the construction operations. The mailboxes and their supports, when
36 reset, shall be left in as good a condition as they were before removal. The Contractor will
37 not be required to furnish new material except as required to repair damage resulting from
38 construction operations.

39 The Contractor will be held responsible for all damage or injury to property of any character
40 resulting from any act, omission, negligence, or misconduct in the prosecution of the work.
41 When any direct or indirect damage or injury is done to public or private property by or on
42 account of any act, omission, negligence, or misconduct in the execution of the work, he shall
43 either restore at his own expense such property to a condition similar or equal to that existing
44 before such damage or injury was done, or shall make good such damage or injury in
45 a manner acceptable to the owner of the damaged property and to the Department. In case of
46 failure on the part of the Contractor to restore such property or make good such damage or
47 injury, the Department may, at the Contractor's expense, repair, rebuild, or otherwise restore
48 such property in such manner as the Engineer may consider necessary.

Section 107

1 **107-12 CONTROL OF EROSION, SILTATION AND POLLUTION**

2 **(A) General**

3 The Contractor shall take whatever measures are necessary to minimize soil erosion and
4 siltation, water pollution and air pollution caused by his operations. The Contractor shall
5 comply with the applicable regulations of all legally constituted authorities relating to
6 pollution prevention and control. The Contractor shall keep himself fully informed of all
7 such regulations that in any way affect the conduct of the work and shall at all times
8 observe and comply with all such regulations. In the event of conflict between such
9 regulations and the specifications, the more restrictive requirements shall apply.

10 The Engineer will limit the area over which clearing and grubbing, excavation, borrow
11 and embankment operations are performed whenever the Contractor's operations do not
12 make effective use of construction practices and temporary measures which will
13 minimize erosion, or whenever construction operations have not been coordinated to
14 effectively minimize erosion, or whenever permanent erosion control features are not
15 being completed as soon as permitted by construction operations.

16 Following completion of any construction phase or operation, on any graded slope or any
17 area greater than one acre, the Contractor shall provide ground cover sufficient to restrain
18 erosion within 21 calendar days or within a time period specified by the
19 NCG 010000 Construction Permit. The ground cover shall be either temporary or
20 permanent and the type specified in the contract.

21 **(B) Erosion and Siltation Control**

22 The Contractor shall exercise every reasonable precaution throughout the life of the
23 project to prevent the eroding of soil and the silting of rivers, streams, lakes, reservoirs,
24 other water impoundments, ground surfaces or other property.

25 Before suspension of operations on the project or any portion thereof, the Contractor shall
26 take all necessary measures to protect the construction area, including, but not limited to,
27 borrow sources, soil type base course sources and waste areas from erosion during the
28 period of suspension.

29 Unless otherwise approved in writing by the Engineer, construction operations in rivers,
30 streams and water impoundments shall be restricted to those areas where channel changes
31 are shown in the plans and to those areas which must be entered for the construction or
32 removal of temporary or permanent structures.

33 Excavated materials shall not be deposited, nor shall earth dikes or other temporary earth
34 structures be constructed, in rivers, streams, or impoundments. As an exception to the
35 above, confined earth materials will be permitted when approved in writing by the
36 Engineer.

37 Frequent fording of live streams with construction equipment will not be permitted;
38 therefore, temporary bridges or other structures shall be used wherever frequent stream
39 crossings are necessary. Unless otherwise approved in writing by the Engineer,
40 mechanized equipment shall not be operated in live streams except as may be necessary
41 to construct channel changes and to construct or remove temporary or permanent
42 structures.

(C) Coordination of Erosion Control Operations

Temporary and permanent erosion control measures shall be provided as shown in the plans or as directed by the Engineer. All permanent erosion control work shall be incorporated into the project at the earliest practicable time. Temporary erosion control measures shall be coordinated with permanent erosion control measures and all other work on the project to assure economical, effective and continuous erosion control throughout the construction and post construction period and to minimize siltation of rivers, streams, lakes, reservoirs, other water impoundments, ground surfaces, or other property.

Temporary erosion control measures shall include, but not be limited to, the use of temporary berms, dikes, dams, drainage ditches, silt basins, silt ditches, slope drains, structures, vegetation, mulches, mats, netting, gravel, or any other methods or devices that are necessary. Temporary erosion control measures may include work outside the right-of-way or construction limits where such work is necessary as a result of construction such as borrow operations, haul roads, plant sites, equipment storage sites and disposal of waste or debris. The Contractor shall be liable for all damages to public or private property caused by silting or slides originating in waste areas furnished by the Contractor.

Materials for temporary erosion control measures shall have been approved by the Engineer before being used or shall be as directed by the Engineer. The Contractor shall acceptably maintain erosion control measures installed.

(D) Water and Air Pollution

Exercise every reasonable precaution throughout the life of the project to prevent pollution of ground waters and surface waters, such as rivers, streams and water impoundments. Do not discharge onto the ground or surface waters any pollutants such as chemicals, raw sewage, fuels, lubricants, coolants, hydraulic fluids, bitumens and any other petroleum products. Operate and maintain equipment on site in a manner as to prevent the potential or actual pollution of surface or ground waters of the State. Dispose of spent fluids in accordance with applicable Federal and State disposal regulations. Immediately clean up any spilled fluids to the extent practicable and dispose of properly.

Manage, control and dispose of litter on site such that no adverse impacts to water quality occur. Comply with all Federal, State or local air pollution regulations throughout the life of the project.

(E) Dust Control

The Contractor shall control dust throughout the life of the project within the project area and at all other areas affected by the construction of the project, including, but not specifically limited to, unpaved secondary roads, haul roads, access roads, disposal sites, borrow and material sources and production sites. Dust control shall not be considered effective where the amount of dust creates a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property.

The Contractor will not be directly compensated for any dust control measures necessary, as this work will be incidental to the work covered by the various contract items.

(F) Application of Specifications

Article 107-12 shall apply to all construction operations. Further references and detailed requirements concerning erosion, siltation and pollution prevention and control are given in other sections of the *Standard Specifications* as supplements to the general requirements of this article.

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1 (G) Sanctions

2 In the event that temporary erosion and pollution control measures become necessary due
3 to the Contractor's negligence, carelessness, or failure to incorporate permanent erosion
4 control measures into the project at the earliest practicable time, such measures shall be
5 performed by the Contractor as directed by the Engineer at no cost to the Department. If
6 the Contractor fails to perform such measures as directed, the Engineer may have the
7 work performed in accordance with Article 105-16.

8 Failure of the Contractor to fulfill any of the requirements of this article may result in the
9 Engineer ordering the stopping of construction operations in accordance with
10 Article 108-7 until such failure has been corrected. Such suspension of operations will
11 not justify an extension of contract time.

12 Failure on the part of the Contractor to perform the necessary measures to control
13 erosion, siltation and pollution will result in the Engineer notifying the Contractor to take
14 such measures. In the event that the Contractor fails to perform such measures within
15 24 hours after receipt of such notice with adequate forces and equipment, the Engineer
16 may suspend the work as provided above, or may proceed to have such measures
17 performed with other forces and equipment, or both. No payment will be made to the
18 Contractor for the performance of this work and the cost of such work so performed will
19 be deducted from monies due the Contractor on his contract.

20 107-13 PROTECTION OF PUBLIC LANDS

21 In the execution of any work within or adjacent to any National or State forest, park or other
22 public lands, the Contractor shall comply with all regulations of all authorities having
23 jurisdiction over such forest, park or lands, governing the protection of public lands and the
24 carrying out of work within public lands and shall observe all sanitary laws and regulations
25 with respect to the performance of work in public lands. He shall keep the areas in an orderly
26 condition, properly dispose of all refuse and obtain permits for the construction and
27 maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools,
28 septic tanks and other structures in accordance with the regulations of the appropriate
29 authorities.

30 The Contractor shall take all reasonable precaution to prevent and suppress forest fires and
31 shall require his employees and subcontractors, both independently and at the request of forest
32 officials, to do all reasonable within their power to prevent and suppress and to assist in
33 preventing and suppressing forest fires and to make every possible effort to notify a forest
34 official at the earliest possible moment of the location and extent of any fire seen by them.

35 The Contractor shall obtain any construction permits that may be required for his operations,
36 which are not a part of the project, in accordance with the regulations of the appropriate
37 authorities.

38 107-14 RESPONSIBILITY FOR DAMAGE CLAIMS

39 The Contractor shall indemnify and save harmless the Board and its members and the
40 Department, its officers, agents and employees from all suits, actions, or claims of any
41 character brought for any injury or damages received or sustained by any person, persons, or
42 property by reason of any act of the Contractor, subcontractor, its agents or employees, in the
43 performance of the contract. The Contractor's liability to save harmless and indemnify shall
44 include, but not by way of limitation, the following:

45 (A) Damages or claims for the failure of the Contractor to safeguard the work;

46 (B) Damages or claims by reason of the failure of the Contractor to erect adequate barricades
47 and post adequate warnings to the public of such barricades;

48 (C) Any damage or claims caused through the Contractor's use of defective materials or by
49 the performance of defective work;

- 1 (D) Any claims by reason of the Contractor's infringement of patent, trademark, or copyright;
 2 (E) Any amounts paid by the Department by reason of the Contractor's failure to comply with
 3 or for violations of laws, ordinances, orders, or decrees;
 4 (F) Any damages or claims caused by blasting operations of the Contractor with or without
 5 proof of negligence on the part of the Contractor;
 6 (G) Damages or claims caused by the failure of the Contractor to protect private or public
 7 property pursuant to Article 107-11, including damages to public and private property
 8 caused by silting and slides from waste areas furnished by the contractor, without proof
 9 of negligence; and
 10 (H) Damages caused by the failure of the Contractor to control erosion in accordance with the
 11 contract.

12 In addition to any remedy authorized by law, the Department shall have a right to retain from
 13 monies due the Contractor, as the Department considers necessary until final disposition has
 14 been made of the following suits or claims:

- 15 (1) For all claims against the Department involving claims or damages that are the
 16 Contractor's responsibility under Section 107. The Contractor and the Surety shall
 17 remain responsible until such suits or claims against the Department have been
 18 settled and until the Department has been indemnified and saved harmless.
 19 (2) In case of claims by third parties against the Contractor involving tort liability for
 20 which the Department might be held liable for as a taking of property, or as a tort
 21 before the Industrial Commission. However, monies due the Contractor will not be
 22 retained provided the Contractor produces satisfactory evidence to the Department
 23 that he is adequately protected from such tort liability by public liability and property
 24 damage insurance. In all other cases involving claims or suits by third parties against
 25 the Contractor, amounts due the Contractor will not be withheld provided that the
 26 consent of the Surety is furnished and the Surety guarantees payment of any amounts
 27 for which the Contractor may be determined to be legally liable.
 28 (3) In cases of damage to property of the Department, such amounts necessary to pay for
 29 such damage.

30 In cases where claims are made or suits filed against the Board or its members and the
 31 Department, its officers, agents and employees, the Department may retain from any monies
 32 due the Contractor, an amount sufficient to indemnify such member of the Board or officer,
 33 agent or employee of the Department for any amounts which they may be held liable for but
 34 for which the Contractor is responsible under Section 107. In the event that there is not
 35 sufficient monies available from the final estimate, the Department may collect from the
 36 Contractor or its Surety amounts sufficient to indemnify such employee, agent or officer of
 37 the Department or member of the Board for such damages incurred.

38 **107-15 LIABILITY INSURANCE**

39 The Contractor shall be liable for any losses resulting from a breach of the terms of this
 40 contract. The Contractor shall be liable for any losses due to the negligence or willful
 41 misconduct of its agents, assigns and employees including any sub-contractors which causes
 42 damage to others for which the Department is found liable under the Torts Claims Act, or in
 43 the General Courts of Justice, provided the Department provides prompt notice to the
 44 Contractor and that the Contractor has an opportunity to defend against such claims. The
 45 Contractor shall not be responsible for punitive damages.

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1 The Contractor shall at its sole cost and expense obtain and furnish to the Department
2 an original standard Association for Cooperative Operations Research and
3 Development (ACORD) form certificate of insurance evidencing commercial general liability
4 with a limit for bodily injury and property damage in the amount of \$5,000,000 per
5 occurrence and general aggregate, covering the Contractor from claims or damages for bodily
6 injury, personal injury, or for property damages that may arise from operating under the
7 contract by the employees and agents of the Contractor. The required limit of insurance may
8 be obtained by a single general liability policy or the combination of a general liability and
9 excess liability or umbrella policy. The State of North Carolina shall be named as an
10 additional insured on this commercial general liability policy. The policy may contain the
11 following language as relates to the State as an additional insured: "This insurance with
12 respect to the additional insured applies only to the extent that the additional insured is held
13 liable for your or your agent's acts or omissions arising out of and in the course of operations
14 performed for the additional insured."

15 The Contractor shall maintain all legally required insurance coverage, including without
16 limitation, worker's compensation and vehicle liability, in the amounts required by law.
17 Providing and maintaining adequate insurance coverage is a material obligation of the
18 contractor and is of the essence of this contract. All such insurance shall meet all laws of the
19 State of North Carolina. Such insurance coverage shall be obtained from companies that are
20 authorized to provide such coverage and that are authorized by the Commissioner of
21 Insurance to do business in North Carolina. The Contractor shall at all times comply with the
22 terms of such insurance policies.

23 Upon execution of the contract, provide evidence of the above insurance requirements to the
24 Engineer. When required by the contract, the Contractor shall carry insurance of the kinds
25 and in the amounts specified therein in addition to any other forms of insurance or bonds
26 required under the terms of the contract, or any other insurance carried by the Contractor.

27 **107-16 OPENING SECTIONS OF PROJECT TO TRAFFIC**

28 If it is determined by the Engineer that the Contractor will not complete the work by the
29 completion date, intermediate completion date, or intermediate completion time, the Engineer
30 may notify the Contractor in writing that upon expiration of contract time or intermediate
31 contract time the project, or any portion thereof, will be open to traffic. On such sections that
32 are opened, the Contractor shall conduct the remainder of his operations so as to cause the
33 least obstruction to traffic. The Contractor shall not be relieved of his liability or
34 responsibility, shall not receive any additional compensation due to the added cost of the
35 work, nor shall he receive any extension of the completion date, intermediate completion date,
36 or intermediate completion time, by reason of such openings.

37 **107-17 CONTRACTOR'S RESPONSIBILITY FOR WORK**

38 Until final acceptance of the work by the Engineer, as evidenced in writing, the Contractor
39 shall have the charge and care thereof and shall take every precaution against injury or
40 damage to any part thereof by the action of the elements, or from any other cause, whether
41 arising from the execution or from the nonexecution of the work. The Contractor shall
42 rebuild, repair, restore and make good all injuries or damages to any portion of the work
43 occasioned by any of the above causes before final acceptance and shall bear the expense
44 thereof, except as provided in other sections of the Specifications. The Department will
45 reimburse the Contractor for the repair of the work due to actions of the elements of such
46 exceptional nature as to be contractually classified as Acts of God.

47 In case of suspension of work from any cause whatsoever, the Contractor shall be responsible
48 for all materials and shall properly store them, if necessary, and shall provide suitable
49 drainage of the roadway and erect necessary temporary structures at no cost to the
50 Department.

107-18 FURNISHING RIGHT OF WAY

The Department will be responsible for the securing of all necessary rights of way.

107-19 PERSONAL LIABILITY OF PUBLIC OFFICIALS

The Board and its members and the Department's officers, agents and employees shall not be held personally liable for any damages connected with the work, it being specifically understood in all such matters that they act solely as agents and representatives of the Board or the Department.

107-20 WAIVER OF LEGAL RIGHTS BY THE DEPARTMENT

Upon completion of the work, the Department will expeditiously make an inspection and notify the Contractor of acceptance. Such final acceptance and processing of the final estimate, however, shall not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Department be precluded or estopped from recovering from the Contractor or his Surety, or both, such overpayment as it may sustain, or by failure on the part of the Contractor to fulfill his obligations under the contract. A waiver on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Department's rights under any warranty or guaranty.

107-21 SAFETY AND ACCIDENT PROTECTION

The Contractor shall comply with all applicable Federal, State and local laws, ordinances and regulations governing safety, health and sanitation, and shall provide all safeguards, safety devices and protective equipment, and shall take any other needed actions, on his own responsibility, that are reasonably necessary to protect the life and health of employees on the job and the safety of the public, and to protect property in connection with the performance of the work covered by the contract.

All Contractors' personnel, all subcontractors and their personnel, and any material suppliers and their personnel shall wear a reflective vest or outer garment conforming to MUTCD at all times while on the project.

107-22 WAGES AND CONDITIONS OF EMPLOYMENT

The Contractor's attention is directed to the provisions and requirements of any and all public statutes that regulate hours or conditions of employment on public work. Such provisions and requirements that are appropriate, in accordance with the intent of the particular law, act, or statute, will be applicable to all work performed by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence and to all work performed by subcontract. It shall be the responsibility of the Contractor to ascertain the appropriate application of such provisions and requirements to the work.

In addition to the general requirements of the various regulations referred to above, certain additional regulations and restrictions may be imposed that are peculiar to the particular work under the contract. In such cases, these regulations and restrictions will be included in the contract for the particular project involved.

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1 For projects that are financed wholly or in part with Federal funds, the minimum wage rates to
2 be paid to all mechanics and laborers employed on the project will be determined by the
3 U.S. Secretary of Labor. A schedule of such wage rates will be included in the proposal for
4 such projects. The Contractor shall provide at the job site at no cost to the Department
5 a weatherproof bulletin board covered with glass or rigid transparent plastic and shall display
6 thereon at all times the required federal aid posters with regard to employment and wages that
7 will be furnished to him. The bulletin board shall be located in a conspicuous place easily
8 accessible to all employees.

9 In the event that changes should occur in any of the regulations referred to in this article, or in
10 any application thereof to the work under contract, no additional compensation will be
11 allowed the Contractor as a result of such changes.

12 **107-23 LIABILITY TO THIRD PARTIES**

13 It is not intended by any of the provisions of any part of these specifications to make the
14 public or any member thereof a third party beneficiary hereunder, or to authorize anyone who
15 is not a party to a contract entered into pursuant to these specifications to maintain a suit for
16 personal injury or property damage otherwise than as authorized and provided by law.

17 **107-24 RIGHT OF THE CONTRACTOR TO FILE VERIFIED CLAIM**

18 If the Contractor fails to receive such settlement as he claims to be entitled to under the terms
19 and provisions of the contract, the Contractor may submit a written and verified claim for
20 such amounts he deems himself or his subcontractor entitled to under the terms and provisions
21 of the contract provided he has complied with the applicable provisions of the contract
22 including, but not limited to, giving written notice of intent to file a claim, keeping and
23 submission of cost records and the initial submission of a written claim within the specified
24 time period. The claim shall be submitted to the State Highway Administrator within 60 days
25 from the time the Contractor receives the final estimate as defined by Section 101 and shall be
26 submitted in accordance with NCGS § 136-29.

27 Submission of records by the Contractor and physical acceptance by the Department, during
28 the course of the project shall not be construed as an admission of liability by the Department
29 and shall be accepted by the Department for record keeping purposes only and not as
30 an acknowledgement of entitlement by the Contractor.

31 **107-25 HAZARDOUS, CONTAMINATED AND TOXIC MATERIAL**

32 When the Contractor's operations encounter or expose any abnormal condition that may
33 indicate the presence of a hazardous, contaminated, or toxic material, such operations shall be
34 discontinued in the vicinity of the abnormal condition and the Engineer shall be notified
35 immediately. Upon notification by the Contractor, the Engineer will investigate the work,
36 consult the GeoEnvironmental Section of the Geotechnical Engineering Unit and, if
37 necessary, suspend the work in accordance with Article 108-7. The presence of storage
38 drums or barrels; old or abandoned underground storage tanks; discolored earth, metal, wood,
39 etc.; visible fumes; abnormal odors; excessively hot earth; smoke; or anything else that
40 appears abnormal may be indicators of hazardous, contaminated or toxic materials and shall
41 be treated with extraordinary caution as they are evidence of abnormal conditions.

42 The Contractor's operations shall not resume until so directed by the Engineer.

43 Disposition of the hazardous, contaminated, or toxic material will be made in accordance with
44 Federal, State and local requirements and regulations. Where the Contractor performs work
45 necessary to dispose of hazardous, contaminated, or toxic material, payment will be made at
46 the unit prices for pay items included in the contract that are applicable to such work. Where
47 the contract does not include such pay items, the Engineer may have the work performed by
48 others or the Contractor may perform the work in accordance with Article 104-7 for extra
49 work and the following paragraphs.

1 The Contractor shall employ a fully experienced and prequalified geoenvironmental firm to
2 oversee and document the disposal of contaminated material removed from within the project
3 right of way. The Contractor shall furnish and deliver to the Department 3 Contaminant
4 Removal Reports accompanied by all documents necessary to meet the laws, rules and
5 regulations of the environmental regulatory agency(ies) having jurisdiction over each
6 respective site from which contaminated materials are removed. Reports documenting the
7 Contractor's work and laboratory analyses of collected samples shall be submitted to the
8 Department within 30 calendar days after completion of the removal of the contaminated
9 materials. If the Contractor removes any underground storage tanks (UST), a UST Closure
10 Report shall be presented to the Department within 25 calendar days after receipt of
11 laboratory data. The Contractor shall not submit any reports directly to the regulatory
12 agencies. The Contractor shall provide to the Department a Certificate of Remediation from
13 the disposing/treating facility within 60 days after removal of the materials from the project
14 site unless alternate arrangements are approved in writing by the Department.

15 Contaminated material removed during construction shall be transported to a waste treatment
16 and disposal facility that is fully approved and permitted by all applicable environmental
17 regulatory agencies to receive, treat and/or dispose of the material. It shall be the Contractor's
18 responsibility to locate such a facility. Departmental approval of the specific facility
19 identified for use by the Contractor shall occur before removal of any materials from the
20 project limits. Contaminated material shall only be removed to the extent necessary to
21 complete a task or as directed by the Engineer. Remaining contamination shall be left in
22 place and documented in reports provided to the Department. The Contractor shall provide
23 the Department with all transportation manifests and certificates of acceptance from the
24 receiving disposal facility weekly. The Department will be the regulatory generator of all
25 waste excavated and removed from within its right of way. The Contractor, with the approval
26 of the Engineer, is authorized to sign all waste transportation and disposal manifests on behalf
27 of the Department.

28 The Contractor shall maintain qualified personnel on-site at all times during removal of
29 materials from within known areas of contamination for field screening and to monitor
30 ambient air quality. The qualified personnel shall be knowledgeable with the use of
31 an Organic Vapor Analyzer, Flame Ionization Detector, Photo Ionization Detector, or other
32 appropriate monitoring equipment. In the event that there is a need to stockpile contaminated
33 material, the Contractor shall stockpile all contaminated soil excavated from a parcel in
34 a location within the property boundaries of the source parcel in accordance with the Standard
35 Stockpile Containment Detail. If the volume of contaminated material exceeds available
36 space on site, the Contractor shall obtain a permit from the NCDENR UST Section for off-site
37 temporary storage.

38 The Contractor shall be entirely responsible for compliance with all OSHA, EPA, DOT,
39 DENR and local rules and regulations pertaining to excavation, transportation and
40 treatment/disposal of the contaminated material. Examples of such rules and regulations
41 include, but are not limited to, 29 CFR 1910 and 1926, 40 CFR 260 - 265,
42 49 CFR 173 and 178, 15A NCAC 13A North Carolina Hazardous Waste Management Rules,
43 NCGS § 130A-310 Inactive Hazardous Sites, the Federal Comprehensive Environmental
44 Response, Compensation and Liability Act (CERCLA) and the Federal Resource
45 Conservation and Recovery Act (RCRA). It must be noted that inclusion of this paragraph is
46 meant to highlight the Contractor's responsibility for regulatory compliance in all phases of
47 work on this project.

48 **107-26 FINES AND LEVIES AGAINST THE DEPARTMENT**

49 In the event there are fines or charges levied against the Department, actions taken by the
50 Department, or remediation required by the Department due to the contractor's negligence,
51 carelessness, or failure, due to violations charged to the Contractor, or due to the Contractor's
52 failure to comply with the contract, monies will be deducted from monies to be paid to the
53 Contractor on this project.

**SECTION 108
PROSECUTION AND PROGRESS**

108-1 GENERAL

It is the intent of these Specifications that the Contractor shall commence work on the date of availability shown in the contract or as soon thereafter as practicable, except that when required by permits included in the proposal, that work in jurisdictional waters and wetlands shall not begin until a meeting is held between the Department, Regulatory Agencies and the Contractor. The Contractor shall not begin work before the date of availability without written approval of the Engineer. If such approval is given, the Department will assume no responsibility for any delays caused before the date of availability by any reason whatsoever, and such delays, if any, will not constitute a valid reason for extending the completion date.

The Contractor shall pursue the work diligently with workmen in sufficient numbers, abilities and supervision, and with equipment, materials and methods of construction as may be required to complete the work described in the contract or as may be amended by the completion date.

108-2 PROGRESS SCHEDULE

The Contractor shall prepare and submit for review and approval a schedule of proposed working progress. This schedule shall be submitted on forms supplied by the Engineer or in a format that is approved by the Engineer. A detailed Critical Path Method (CPM) schedule shall not be submitted to replace the progress schedule details required below.

The proposed progress schedule shall be submitted no later than 7 days before the date of the project preconstruction conference and shall be approved before any payments will be processed for the project.

When the Engineer has extended the completion date or if the project overrun is anticipated to exceed 5%, the Contractor may submit a revised progress schedule to the Engineer for review and approval. If plan revisions are anticipated to change the sequence of operations in such a manner as will effect the progress but not the completion date, then the Contractor may submit a revised progress schedule for review and approval but the completion date shall remain unchanged.

The proposed progress schedule shall contain the following items:

(A) A time scale diagram with major work activities and milestone dates clearly labeled.

(1) For purposes of composing the progress schedule, major work activities are defined as components comprising more than 5% of the total project cost or occupying more than 10% of total contract time and shall include, if applicable, the following:

- (a) Clearing and grubbing
- (b) Grading
- (c) Drainage
- (d) Soil stabilization
- (e) Aggregate base course
- (f) Pavement
- (g) Culverts
- (h) Bridges (including removal)
- (i) Signals, ITS and lighting
- (j) Overhead signs

- 1 (2) For purposes of composing the progress schedule, major milestones are derived from
2 the project construction phasing and shall include, if applicable, the following:
- 3 (a) Start of construction
 - 4 (b) Intermediate completion dates or times
 - 5 (c) Seasonal limitation/observation periods/moratoriums
 - 6 (d) Traffic shifts
 - 7 (e) Beginning and end of each traffic control phase or work area
 - 8 (f) Road openings
 - 9 (g) Completion date
- 10 **(B)** A cash curve corresponding to the milestones and work activities established in
11 Subarticle 108-2(A) above.
- 12 **(C)** A written narrative that explains the sequence of work, the controlling operations,
13 intermediate completion dates, milestones, project phasing, anticipated work schedule
14 and estimated resources. In addition, explain how permit requirements, submittal
15 tracking and coordination with subcontractors, utility companies and other entities will be
16 performed.

17 **108-3 PRECONSTRUCTION CONFERENCE**

18 Immediately after receipt of notice of award, the Division Engineer and the Contractor will
19 establish a mutually agreeable date on which the preconstruction conference will be held. The
20 Contractor's project superintendent and other individuals representing the Contractor who are
21 knowledgeable of the Contractor's proposed progress schedule or who will be in charge of
22 major items of the work shall attend the preconstruction conference.

23 **108-4 CONSTRUCTION CONFERENCES**

24 After work on the project has begun, construction conferences will be held periodically. The
25 construction conferences are to be scheduled at times that are mutually agreeable to both the
26 project superintendent and the Resident Engineer. It shall be the superintendent's
27 responsibility to attend the conferences.

28 **108-5 CHARACTER OF WORKMEN, METHODS AND EQUIPMENT**

29 The Contractor shall at all times employ sufficient labor and equipment for prosecuting the
30 several classes of work to full completion in the manner and time required by the *Standard*
31 *Specifications*.

32 The Contractor shall not recruit Department employees for employment. Additionally,
33 Department employees who elect to become employed by a Contractor may not perform any
34 function on a project with which they have been involved during employment with the
35 Department without written consent of the State. Any person employed by the Contractor and
36 assigned to a project who has previously been involved in the project as a Department
37 employee shall be, at the written direction of the Engineer, removed from the project.
38 An exception to these terms may be granted when recommended by the Secretary and
39 approved by the Board.

40 Failure of the Contractor to comply may be justification for disqualifying him from further
41 bidding in accordance with Article 102-15 and shall be grounds for termination of this
42 contract.

43 No person shall be employed by the Contractor or by any subcontractor who has been
44 determined by the Engineer to have engaged in fraudulent activities in connection with any
45 work for the Department.

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1 Any person employed by the Contractor or by any subcontractor who, in the opinion of the
2 Engineer, does not perform his work in a proper and skillful manner or is disrespectful,
3 intemperate, or disorderly or who has been determined by the Engineer to have engaged in
4 fraudulent activities in connection with any work for the Department shall, at the written
5 request of the Engineer, be removed forthwith by the Contractor or subcontractor employing
6 such person and shall not be employed again in any portion of the work without the approval
7 of the Engineer.

8 Should the Contractor fail to remove such persons as required above, the Engineer may
9 suspend the work in accordance with Article 108-7.

10 All equipment proposed to be used on the work is to be of sufficient size and in such
11 mechanical condition as to meet the requirements of the work and to produce a satisfactory
12 quality of work. Equipment used on any portion of the project shall be such that no injury to
13 the roadway, adjacent property, or other highways will result from its use. The Engineer may
14 order in writing the removal and replacement of any unsatisfactory equipment.

15 When the methods and equipment to be used by the Contractor in accomplishing the
16 construction are not prescribed in the contract, the Contractor is free to use any methods or
17 equipment that he demonstrates to the satisfaction of the Engineer will accomplish the
18 contract work in conformity with the contract.

19 When the contract specifies that the construction be performed by the use of certain methods
20 and equipment, such methods and equipment shall be used unless others are approved by the
21 Engineer. If the Contractor desires to use a method or type of equipment other than those
22 specified in the contract, he may request approval from the Engineer to do so. The request
23 shall be in writing and shall include a full description of the methods and equipment proposed
24 to be used and an explanation of the reasons for desiring to make the change. If approval is
25 given it will be on the condition that the Contractor will be fully responsible for producing
26 construction work in conformity with contract requirements. If, after trial use of the
27 substituted methods or equipment, the Engineer determines that the work produced does not
28 meet contract requirements, the Contractor shall discontinue the use of the substitute method
29 or equipment and shall complete the remaining construction with the specified methods and
30 equipment. The Contractor shall remove the unsatisfactory work and replace it with work of
31 specified quality, or take such other corrective action as the Engineer may direct. No change
32 will be made in basis of payment for the construction items involved or in the completion date
33 as a result of authorizing a change in methods or equipment under these provisions.

34 **108-6 SUBLETTING OF CONTRACT**

35 The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or
36 any portion thereof; or of his right, title, or interest therein; without written consent of the
37 Engineer. In case such consent is given, the sublet work shall be performed by the
38 subcontractor unless otherwise approved in writing by the Engineer. Failure of the Contractor
39 to comply with the *Standard Specifications* will be just cause for the work to be considered
40 unauthorized in accordance with Article 105-12. A firm that has been disqualified due to its
41 failure to maintain satisfactory progress under Article 108-8 will not be approved as
42 a subcontractor until the firm demonstrates the ability to perform the work in a satisfactory
43 manner. When directed by the Engineer, the Contractor shall submit a certified copy of the
44 actual subcontract agreement executed between the Contractor and subcontractor before
45 written consent being issued by the Engineer. In case such consent is given, the Contractor
46 will be permitted to sublet a portion thereof, but shall perform with his own organization,
47 work amounting to not less than 40% of the total original contract amount, except:

48 (A) Any items designated in the contract as specialty items may be performed by subcontract
49 and the cost of any such special items so performed by subcontract will be deducted from
50 the total amount bid before computing the amount of work required to be performed by
51 the Contractor with his own organization, and

1 (B) Any other items sublet to Disadvantaged Business Enterprise (DBE), Minority
2 Business (MB) or Women's Business (WB), up to the value of the contract DBE, MB or
3 WB goal, will be deducted from the total amount bid before computing the amount of
4 work required to be performed by the Contractor with his own organization.

5 In any event, the Contractor shall perform with his own organization work amounting to not
6 less than 35% of the difference between the total amount bid and the value of specialty items
7 that have been sublet.

8 Extra work performed in accordance with Article 104-7 will not be considered in the
9 computation of work required to be performed by the Contractor.

10 An assignment by operations of law or assignment for the benefit of creditors, or the
11 bankruptcy of the Contractor, shall not vest any right in this contract in the Trustee in
12 bankruptcy, the Contractor's creditors, or the agent of the creditors.

13 A subcontractor shall not sublet, sell, transfer, assign, or otherwise dispose of his contract
14 with a contractor or any portion thereof; or of his right, title, or interest therein; without
15 written consent of the Engineer. When directed by the Engineer, the contractor shall submit
16 a certified copy of the actual subcontract agreement executed between the subcontractor and
17 the second tier subcontractor. In the event of an assignment by operations of law or the
18 bankruptcy of the subcontractor, the contractor shall have the right, power and authority, in his
19 discretion, without violating the contract or releasing the Surety, to terminate the subcontract.
20 An assignment by operations of law or assignment for the benefit of creditors or the
21 bankruptcy of the subcontractor shall not vest any right in this contract in the Trustee in
22 bankruptcy, nor the subcontractor's creditors or agents of the creditors.

23 Neither the Contractor, nor any subcontractor, shall enter into any written or oral equipment
24 lease or rental agreement, materials purchase agreement or labor agreement that circumvents
25 this article.

26 If the Contractor or a subcontractor enters into a lease or rental agreement for equipment
27 based upon payment for a unit of work, such agreement will be considered subletting of the
28 contract unless the lease or rental agreement is with a commercial equipment company,
29 manufacturer or commercial leasing agency and such firm has been approved by the
30 Engineer. An equipment lease or rental agreement that is based upon unit prices per unit of
31 time will not be considered subletting of the contract.

32 The approval of any subcontract will not release the Contractor of his liability under the
33 contract and bonds, nor will the subcontractor or the second tier subcontractor have any claim
34 against the Department by reason of the approval of the subcontract. The State Highway
35 Administrator will review and consider subcontractor claims for additional time or
36 compensation provided such claims are submitted by the Contractor in accordance with
37 Article 107-24 and NCGS § 136-29.

38 Failure of the Contractor to comply with any of the requirements of this article may be
39 justification for disqualifying the Contractor from further bidding in accordance with
40 Article 102-15.

41 **108-7 TEMPORARY SUSPENSION OF THE WORK**

42 The Engineer will have the authority to suspend the work wholly or in part by written order
43 for such periods, as he may deem necessary for any of the following reasons:

- 44 (A) Conditions considered unfavorable for the suitable prosecution of the work, or
- 45 (B) The Contractor's failure to correct conditions unsafe for workmen or the general public,
46 or
- 47 (C) The Contractor has not carried out orders given to him by the Engineer, or
- 48 (D) The Contractor's failure to perform any provisions of the contract.

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1 No extension of the completion date will be allowed for the above suspensions except as may
2 be provided for in Article 108-10.

3 **108-8 FAILURE TO MAINTAIN SATISFACTORY PROGRESS**

4 The Engineer will check the Contractor's progress at the time each partial pay estimate is
5 prepared. The Contractor's progress may be considered as unsatisfactory as follows:

6 **(A)** The Contractor's progress is found to be less than that described in either count below:

7 (1) The dollar value of the work completed, excluding material payments allowed by
8 Article 109-5, is less than the dollar value of the work that should have been
9 completed, on the basis of the Contractor's approved progress schedule, by more than
10 15% of the current contract amount.

11 The dollar value of the work completed will be the total estimate to date shown in
12 the latest partial pay estimate, excluding material payments allowed by
13 Article 109-5. The current contract amount will be the total amount bid plus
14 accumulated overruns less accumulated underruns shown in the latest partial pay
15 estimate.

16 (2) The percentage of the work completed is less than the percentage of contract time
17 elapsed on the work by more than 15%. The percentage of work completed will be
18 the dollar value of the work completed as defined above, divided by the current
19 contract amount as defined above.

20 The percentage of contract time elapsed will be the number of calendar days elapsed
21 as shown in the latest partial pay estimate divided by the total contract time in
22 calendar days.

23 **(B)** The Contractor fails to begin and pursue the work in accordance with Article 108-1
24 before the expiration of 5% of the original contract time after the date work was
25 scheduled to begin based upon the approved progress schedule.

26 **(C)** The Engineer anticipates the Contractor will not complete the work described in the
27 contract by the intermediate contract time or the contract completion date.

28 When the Contractor's progress is found to be unsatisfactory as described in
29 Subarticles 108-8(A), 108-8(B) and 108-8(C) above, the Engineer may make written demand
30 of the Contractor to state in writing the reason for the unsatisfactory progress and produce
31 such supporting data as the Engineer may require or the Contractor may desire to submit. The
32 Engineer will consider the justifications submitted by the Contractor and extensions of the
33 completion date have or may be allowed in accordance with Subarticle 108-10(B).

34 When the Contractor cannot satisfactorily justify the unsatisfactory progress, the Engineer
35 may invoke one or more of the following sanctions:

36 (1) Withhold anticipated liquidated damages from amounts currently due or that become
37 due.

38 (2) Remove the Contractor and all firms prequalified under the Contractor's
39 Prequalification Number from the Department's Prequalified Bidders List.

40 When any of the above sanctions have been invoked, they shall remain in effect until
41 rescinded by the Engineer.

108-9 DEFAULT OF CONTRACT**(A) Declaration of Default**

The Department shall have the right to declare default of the contract for breach by the Contractor of any material term or condition of the contract as determined by the Department. Material breach by the Contractor shall include, but specifically shall not be limited to failure to begin work under the contract within the time specified; failure to provide workmen, equipment, or materials adequate to perform the work in conformity with the contract by the completion date; unsatisfactory performance of the work; refusal or failure to replace defective work; failure to maintain satisfactory work progress; failure to comply with equal employment opportunity contract requirements; insolvency or bankruptcy, or any act of insolvency or bankruptcy; failure to satisfy any final judgment within 10 calendar days after entry thereof; and making an assignment for benefit of creditors.

(B) Sanctions

In the event of a breach of the contract by the Contractor, the Department shall have the right, power and authority, in its sole discretion, without violating the contract or releasing the Surety: to assume full control of the prosecution of the contract in the place and stead of the Contractor in directing Contractor's agents, employees and subcontractors in the performance of the work and in utilizing all materials, tools, machinery, equipment and structures located on the project; to perform the work or any part thereof with Department personnel and equipment or to use any or all materials and equipment located on the project that are suitable and acceptable; to relet the work upon such terms and conditions as the Department shall deem appropriate; to employ any other methods that it may determine are required for completion of the contract in an acceptable manner; and to withhold any sums due the Contractor under the contract without penalty or interest until the work is completed and accepted by the Department.

(C) Notice

Before invoking any of the sanctions provided for herein, the Department will give the Contractor at least 7 calendar days written notice with a copy to the Surety, that will set forth the breach of contract involved and the sanctions to be imposed. The Department, in its discretion, may grant the Contractor time in excess of 7 calendar days within which to comply with the contract and the time allowed will be set forth in writing. If the Department determines during such period that the Contractor is not proceeding satisfactorily to compliance, it may impose the sanctions after 24 hours notice to the Contractor. If the Department determines that the Contractor is not in compliance at the end of the time allowed, it may immediately impose any of the sanctions set forth herein and will advise the Contractor, in writing, with a copy to the Surety of the sanctions imposed.

(D) Payment

After declaration of default has been made final, the Contractor will be entitled to receive payment for work satisfactorily completed or portions of work satisfactorily completed, less any sums that may be due the Department from the Contractor but in no event shall payment exceed the contract unit or lump sum price for such work. The Department, at its election, may retain the sum due the Contractor, or any portion thereof, without interest or penalty, until the contract work is completed; or it may make payment to the Contractor upon declaration of default for work satisfactorily completed to the date that notice of default is received by the Contractor. The Contractor may be required by the Engineer to carry to a stage of completion satisfactory to the Engineer any work in progress, the value of which, otherwise, would be lost by immediate cessation of work. Payment for such work will be made upon the basis hereinafter set out.

Section 108

1 In the event that the Contractor's employees, equipment, or materials are used in
2 prosecution of the work, or any part thereof, after default is declared, payment to the
3 Contractor may be by contract unit or lump sum prices for the work performed, or, if the
4 Engineer determines that such prices do not represent the value of the work performed,
5 payment for the type of work or services performed will be made on a force account
6 basis, as set forth in Article 109-3, less any sums that may be due the Department; but in
7 no event shall payment exceed the contract unit or lump sum price for such work or
8 services. Determination of the method of payment shall be in the sole discretion of the
9 Engineer, and he will advise the Contractor, in writing, of his determination with
10 reference to the specific type of work or service to be performed.

11 If all costs and expenses incurred by the Department arising out of the breach and
12 imposition of sanctions, together with the total cost to the Department of securing the
13 performance of the work set forth in the contract, exceed the sum that would have been
14 payable under the contract, the Contractor and the Surety shall be liable to the
15 Department for such excess and shall pay such amount to the Department.

16 (E) Power of Engineer

17 The Engineer will exercise the powers and discretion vested in him by the contract in
18 carrying out the terms of this article. He will have full power and authority to carry out
19 any orders, directives, or resolutions issued by the Department in connection with
20 a declaration of default. In the event that the Department fails to specify the sanctions to
21 be imposed, the notice to be given or the method of completing the work, the Engineer
22 may, at his discretion, impose such sanctions, give such notice and select such methods
23 of completing the work, as are authorized by this article; and such actions shall have the
24 same effect and validity as if taken pursuant to an express order, directive or resolution of
25 the Department.

26 (F) Obligation of Contractor and Surety

27 No term or terms of this article and no action taken pursuant hereto by the Department of
28 Transportation, its agents, or employees, will be construed to release or discharge the
29 Contractor or the Surety upon the obligation set forth in the contract bonds, and the
30 Contractor and the Surety shall remain bound thereon unto the Department until the work
31 set forth in the contract has been completed and accepted by the Department and all
32 obligations of the Contractor and the Surety arising under the contract and contract bond
33 have been discharged.

34 (G) Provision Not Exclusive

35 The provisions shall be in addition to and not in place of, any other provisions relating to
36 default, breach of contract and sanctions to be imposed in connection therewith appearing
37 in the contract.

38 108-10 CONTRACT TIME AND INTERMEDIATE CONTRACT TIME

39 (A) General

40 The contract time will be as defined in Section 101. No extensions to the completion
41 date will be authorized except as allowed by this article. No modifications in the date of
42 availability will be made for any reason whatsoever.

43 Intermediate contract time, as defined in Section 101 will be that as allowed in the
44 contract to complete a part, portion or phase of the total work covered in the contract.
45 Intermediate completion dates and intermediate completion times set forth in the contract
46 may be extended on the same basis as completion dates and as described in this article.

47 When the liquidated damages stipulated in the contract are to be hourly, extensions, as
48 described in this article, will be considered on an hourly basis.

1 **(B) Completion Date, Intermediate Completion Date and Intermediate Completion**
 2 **Time Extensions**

3 No extension of the completion date, intermediate completion date, or intermediate
 4 completion time will be allowed for any reason except as provided for below:

5 (1) If the total dollar value of the final quantities adjusted as provided below, less the
 6 dollar value of quantities represented by supplemental agreements that previously
 7 extended the completion date, intermediate completion date or intermediate
 8 completion time, exceeds the dollar value of the total amount bid, the completion
 9 date, intermediate completion date, or intermediate completion time will be extended
 10 by the number of calendar days or hours obtained by multiplying the contract time
 11 (days), intermediate contract time (days), or intermediate contract time (hours) as set
 12 forth in the contract by that percentage that such reduced final dollar value exceeds
 13 the total amount bid. The total dollar value of the final quantities for pro-rata
 14 computations shall be adjusted by excluding the following:

- 15 (a) Unit bid price changes caused by price adjustments to asphalt cement,
- 16 (b) Fuel adjustments,
- 17 (c) Unit price reductions under Article 105-3,
- 18 (d) Payment for trainees and
- 19 (e) Unit price changes due to pay factors established by the *Standard Specifications*.

20 (2) If supplemental agreements covering the performance of extra work include
 21 provisions for an extension of the completion date, intermediate completion date, or
 22 intermediate completion time and the final dollar value of the extra work exceeds the
 23 estimated dollar value, the number of days or the number of hours by which the
 24 completion date, intermediate completion date or intermediate completion time was
 25 extended will be increased by the percentage that the final dollar value exceeds the
 26 estimated value.

27 (3) If the Contractor's current controlling operation is delayed by circumstances
 28 originating from work required under the contract and beyond his control and
 29 without his fault or negligence, he may, at any time before payment of the final
 30 estimate, make a written request to the Engineer on the Contractor Claim Submittal
 31 Form, available through the Construction Unit, for an extension of the completion
 32 date, intermediate completion date, or intermediate completion time. This request
 33 shall include:

- 34 (a) The circumstances resulting in the alleged delay and documentation of said
 35 circumstances as may be required by the Engineer,
- 36 (b) The controlling operation alleged to have been delayed,
- 37 (c) The calendar dates or calendar dates and times on which the controlling
 38 operation was delayed and
- 39 (d) The number of calendar days or hours by which he is requesting the completion
 40 date, intermediate completion date, or intermediate completion time to be
 41 extended.

42 If the Engineer determines that the controlling operation was delayed because of
 43 circumstances beyond the control of and without the fault or negligence of the
 44 Contractor, and that the Contractor has pursued the work in accordance with
 45 Article 108-1, he will extend the completion date, intermediate completion date, or
 46 intermediate completion time unless otherwise precluded by other provisions of the
 47 contract. No extension of the completion date, intermediate completion date, or
 48 intermediate completion time will be allowed for delays caused by restrictions,
 49 limitations or provisions contained in the contract.

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1 Consideration will be given for an extension in the completion date, intermediate
2 completion date, or intermediate completion time involving an intermediate contract
3 time of more than 96 hours if the Contractor's current controlling operation(s) is
4 delayed in excess of 40% of the total contract time (days), as defined in Section 101,
5 excluding the time between December 15 and March 16; the total intermediate
6 contract time (days), as defined in Section 101, excluding the time between
7 December 15 and March 16; or the total intermediate contract time (hours), as
8 defined in Section 101; due to weather or conditions resulting from weather. No
9 other consideration will be given for extensions in the completion date, intermediate
10 completion date, or intermediate completion time due to delays caused by weather.

11 Where the intermediate contract time is 96 hours or less, no consideration
12 whatsoever will be given for an extension in the intermediate completion time due to
13 weather or conditions resulting from weather.

14 (4) If changes in the work from that originally contemplated in the contract are ordered
15 by the Engineer and these changes result in reduction in quantities, elimination of
16 items, additional work or extra work, the Engineer will allow an extension in the
17 completion date, intermediate completion date, or intermediate completion time as
18 he may deem warranted by such changes. Pursuit of the work with adequate forces
19 and equipment and efficiency of the Contractor's operations will be considered by
20 the Engineer in determining an extension in the completion date, intermediate
21 completion date, or intermediate completion time. It is, however, the Contractor's
22 responsibility to show just cause for an extension in the completion date,
23 intermediate completion date, or intermediate completion time due to the aforesaid
24 conditions. If the Contractor elects to file a written claim or requests an extension of
25 contract time, it shall be submitted on the Contractor Claim Submittal Form available
26 through the Construction Unit.

27 (5) In the event accumulated authorized extensions in the completion date or
28 intermediate completion date resulting from Subarticles 108-10(B)(1) through
29 108-10(B)(4) above extend the completion date or intermediate completion date
30 beyond December 15 following expiration of the completion date or intermediate
31 completion date as established in the contract, the completion date will be further
32 extended by the number of calendar days between December 15 of one year and
33 March 16 of the following year. If any portion of such accumulated authorized
34 extensions are for delays that occurred after the original contract time or intermediate
35 contract time (days) expired and during the period between December 15 of one year
36 and March 16 of the following year, this portion of the extension will be deducted
37 from the number of additional calendar days awarded due to extension of the
38 completion date or intermediate completion date beyond December 15.

39 The Contractor's plea that insufficient contract time (days), intermediate contract
40 time (days), or intermediate contract time (hours) was specified in the contract will
41 not be considered as a valid reason for an extension in the completion date,
42 intermediate completion date, or intermediate completion time.

43 When all work on the project is totally complete, with the exception of an item or items on
44 which work is precluded by seasonal limitations set forth in the contract, the Engineer may,
45 provided that the Contractor has diligently pursued the work with adequate forces and
46 equipment, waive the assessment of liquidated damages during the period of time from the
47 date all work other than that precluded by seasonal limitations was completed until the date of
48 expiration of the seasonal limitations. The Contractor shall make the request to waive the
49 assessment of liquidated damages in writing before the beginning date of the requested
50 waiver. The non-assessment of liquidated damages during the aforesaid period shall not
51 operate to waive any other liquidated damages that may be assessable, or any other terms of
52 the contract.

1 108-11 LIQUIDATED DAMAGES

2 Time is an essential element of the contract. Delay in completing the work will result in
3 damages due to public inconvenience, obstruction to traffic, interference with business and
4 the increasing of engineering, inspection and administrative costs to the Department. It is
5 therefore agreed that in view of the difficulty of making a precise determination of such
6 damages, a sum of money in the amount stipulated in the contract, will be charged against the
7 Contractor for each calendar day, each hour, or portion thereof that the work, or any portion
8 of the work as described in the contract, remains uncompleted after the expiration of the
9 completion date, intermediate completion date, or intermediate completion time shown in the
10 contract, not as a penalty but as liquidated damages.

11 Should the Contractor or, in case of default, the Surety fail to complete the work or any
12 portion of the work by any of the applicable completion dates, intermediate completion dates,
13 or intermediate completion times shown in the contract, a deduction of the amount stipulated
14 in the contract as liquidated damages will be made for each and every calendar day, for each
15 and every hour, or portion thereof that the work or any portion of the work remains
16 uncompleted after the expiration of any completion date, intermediate completion date, or
17 intermediate completion time applicable to the uncompleted work. This amount will be
18 deducted from any money due the Contractor or his Surety under the contract and the
19 Contractor and his Surety will be liable for any liquidated damages in excess of the
20 amount due.

21 In the event that the contract establishes one or more intermediate completion dates or times
22 in addition to the completion date, each of the liquidated damages stipulated will be
23 considered to be cumulative to any other liquidated damages stipulated.

24 In case of default of the contract and the completion of the work by the Department, the
25 Contractor and his Surety will be liable for the liquidated damages under the contract, but no
26 liquidated damages will be chargeable for any delay in the final completion of the work by the
27 Department due to any action, negligence, omission, or delay of the Department.

28 In any suit for the collection of or involving the assessment of liquidated damages, the
29 reasonableness of the amount stipulated in the contract will be presumed. The liquidated
30 damages referred to herein are intended to be and are cumulative and will be in addition to
31 every other remedy now or hereafter enforceable at law, in equity, by statute or under the
32 contract.

33 Permitting the Contractor to continue and finish the work or any part thereof after the
34 expiration of the completion date, intermediate completion date, or intermediate completion
35 time shall in no way operate as a waiver on the part of the Department of any of its rights
36 under this contract.

37 108-12 EXTENSION OF CONTRACT TIME AND APPORTIONMENT OF
38 LIQUIDATED DAMAGES

39 In accordance with Articles 108-10 and 108-11, when a contract is not completed by the
40 completion date, intermediate completion date, or intermediate completion time, the
41 Contractor shall be entitled to an extension of the completion date, intermediate completion
42 date, or intermediate completion time and apportionment and remittance of liquidated
43 damages to the extent that the failure to complete was due to the conditions set forth in
44 Article 108-10. The Contractor, however, shall be entitled to an extension of the completion
45 date, intermediate completion date, or intermediate completion time, or an apportionment and
46 remittance of liquidated damages only to the extent and in the proportion that such delays
47 were caused by the conditions set forth in Article 108-10, and it is understood that any
48 extension granted shall not operate to waive any liquidated damages or any claim which the
49 Department has or may have against the Contractor by reason of failure of the Contractor to
50 complete the said contract by the completion date, intermediate completion date, or
51 intermediate completion time specified therein or as revised by authorized extensions.

Section 108

108-13 TERMINATION OF CONTRACT

The Department may terminate the contract in accordance with the following provisions:

(A) Consideration will be given to termination of the contract if any of the following circumstances exist:

- (1) If it is impossible for the Contractor to obtain critical materials for completion of the contract within a practical time limit, or
- (2) If it is impossible for the Contractor to complete the work in accordance with the contract by reason of unanticipated conditions at the site, including slides and unstable subsoil, without a major change in the design of the project and the Contractor will be unduly delayed in completing the project by reason of such unanticipated conditions and changes in design, or
- (3) If the Contractor is prevented from proceeding with the contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense, or
- (4) If the Contractor is prevented from proceeding with the work required by the contract as a direct result of a restraining order, or other court order, or by reason of a permit requirement, and the Contractor will be unduly delayed in completing the project by reason of such order or requirement, or
- (5) If the Contractor is prevented from proceeding with the work due to the unavailability of the site.

(B) The Contractor shall determine when the circumstances in Subarticle 108-13(A) exist and are beyond his control and shall notify the Department in writing of his determination and include adequate documentation of these circumstances along with such notification.

(C) The Contract will be terminated under this article if:

(1) Request by Contractor

- (a) The Department concurs in the determination by the Contractor of the circumstances or makes an independent determination that such circumstances herein above indicated exist, and
- (b) The Department determines that such circumstances are beyond the control of the Contractor, and the Contractor was not at fault in creating the circumstances, and
- (c) The Department determines that a termination of the contract is in the best public interest.

(2) Authority of the Department

The Department determines that a termination of the contract is in the best public interest.

(D) The Contractor will be notified in writing by the State Highway Administrator of the action of the Department.

(E) After a contract is terminated in accordance with this termination provision, the following provisions shall be applicable:

- (1) When the contract is terminated before completion of all items of work in the contract, payment will be made for the actual number of acceptably completed items of work or acceptably completed portions thereof at the contract unit or lump sum prices. When the contract is terminated before completion of all items of work in the contract and items of work are partially completed or not begun, payment will be made in accordance with Article 104-6.

- 1 (2) Payment for costs incurred in organization of the work will be based on verified
 2 actual costs and will be included in the adjusted contract lump sum price for
 3 Mobilization in accordance with Subarticle 108-13(E)(1). The Contractor shall
 4 demonstrate through submission of appropriate documentation that these costs were
 5 included in the bid item of Mobilization. After reviewing the submitted cost records
 6 and the submitted documentation, the Engineer will make such adjustments as he
 7 deems warranted.
- 8 (3) Upon request from the Contractor, materials meeting the requirements of the contract
 9 that were to have been incorporated into the work or were to remain the property of
 10 the Department but are not used in the work will be paid in accordance with
 11 Article 109-6.
- 12 (4) No claim for loss of anticipated profits will be considered and no payment will be
 13 made for loss of anticipated profits.
- 14 (5) Termination of a contract shall not relieve the Contractor of his responsibilities for
 15 any completed portion of the work nor shall it relieve his Surety, of its obligation for
 16 and concerning any just claims arising out of the work performed.

17 **108-14 TERMINATION OF CONTRACTOR'S RESPONSIBILITY**

18 After the project has been completed and accepted, as provided for in Article 105-17, the
 19 Contractor's responsibility will cease except as provided in Article 107-20 and as set forth in
 20 his contract bonds. The Contractor shall remain responsible for any amounts determined to be
 21 owed the Department in the processing of the final estimate and such amounts shall be paid
 22 by the Contractor upon notification by the Department before processing of the final estimate.

23 **SECTION 109**

24 **MEASUREMENT AND PAYMENT**

25 **109-1 MEASUREMENT OF QUANTITIES**

26 All work completed under the contract will be measured by the Engineer according to United
 27 States standard measures unless otherwise stated in the contract.

28 The method of measurement and computations used in the determination of quantities of
 29 material furnished and of work performed under the contract will be those methods generally
 30 recognized as conforming to accepted engineering practice.

31 The terms "gauge" and "thickness," when used in connection with the measurement of plates,
 32 sheets and steel wire, shall be applied as follows:

Item	Test Method
Uncoated Steel Sheets and Light Plates	United States Standard Gauge
Galvanized Sheets	AASHTO M 218 or M 167
Aluminum Sheets	AASHTO M 196 or M 197
Steel Wire	AASHTO M 32

33 The term "ton" will mean short ton (mass) consisting of 2,000 lb.

34 Trucks used to haul material being paid by weight will be either weighed empty before each
 35 loading or weighed empty daily. When trucks are weighed empty daily, each truck shall be
 36 weighed before hauling its first load of the day and shall bear a legible identification mark.

37 Where aggregates that are to be paid by weight have been stockpiled after being produced,
 38 measurement for purposes of payment will be made after the aggregates have been loaded on
 39 trucks for direct delivery to the project.

40 When a complete structure or structural unit, as may be indicated by the unit, lump sum or
 41 each, is specified as the unit of measurement, the unit will be construed to include all
 42 necessary fittings and accessories.

Section 109

1 When standard manufactured items are specified, and these items are identified by gauge, unit
2 weight, section dimensions or other dimensions, such identification will be considered to be
3 nominal weights or dimensions. Unless more stringently controlled by tolerances in cited
4 specifications, manufacturing tolerances established by the industries involved will be
5 accepted.

6 **109-2 SCOPE OF PAYMENT**

7 The Contractor shall receive and accept payment provided for in the contract as full payment
8 for furnishing all materials and performing all work under the contract in a complete and
9 acceptable manner and for all risk, loss, damage, or expense of whatever character arising out
10 of the nature of the work or the prosecution thereof, subject to the requirements of
11 Article 107-20. Payment to the Contractor will be made only for the actual quantities of the
12 various items that are completed and accepted in accordance with the terms of the contract.

13 If the Measurement and Payment clause in the specifications relating to any unit price or lump
14 sum price in the bid schedule requires that the said unit price or lump sum price cover and be
15 considered compensation for certain work or material essential to the item, this same work or
16 material will not be measured or paid under any other pay item that may appear elsewhere in
17 the contract.

18 **109-3 FORCE ACCOUNT WORK**

19 All force account work shall be performed as directed by the Engineer including the numbers
20 and types of equipment, the numbers and classifications of labor and foremen and material
21 requirements.

22 All work to be paid on a force account basis shall be paid in the following manner:

23 **(A) Labor**

24 For all authorized labor and foremen in direct charge of the specific operations, the
25 Contractor will receive the rate of base (actual) wages (or scale) actually being paid by
26 the contractor for each hour that the labor and foremen are actually engaged in the
27 specific force account work.

28 In addition to reimbursement for each hour that the labor and foremen are actually
29 engaged in the specific force account work, the Contractor may receive compensation for
30 travel time to and from the project if and only if the labor and foremen needed are outside
31 a 75 mile radius as included in Subarticle 109-3(B). The base location will be established
32 and approved by the Engineer before performing the specific force account work. If the
33 approved labor and foremen travel to another project upon completion of the specific
34 force account work, payment for travel time may not exceed the travel time that would
35 have been required to return to the point of origin in accordance with
36 Subarticle 109-3(B). When travel time is approved by the Engineer, it shall be included
37 in the total hours approved and worked for that specific week. The Engineer will approve
38 the mode of travel.

39 Before beginning the specific force account work, the Contractor will submit in writing
40 for the Engineer's approval a list of all wage rates applicable to the work. Approval will
41 not be granted where these wage rates are not actually representative of wages being paid
42 elsewhere on the project for comparable classes of labor performing similar work.

1 Payment for overtime will be allowed when approved by the Engineer before performing
2 the specific force account work. Overtime for labor and foremen will be paid based on
3 the company's policy for overtime payment. Verification of such payment will be
4 tracked by submission of weekly payrolls as required on federal projects and as requested
5 on all other projects. Failure to submit payrolls as required or requested shall act as a bar
6 to the Contractor for payment of overtime for labor and foremen. If the labor or foremen
7 is employed partly on specific force account work and partly on other work, the amount
8 of overtime to be reimbursed will be prorated based upon the number of hours worked on
9 the specific force account work during the payroll period.

10 An additive amount equal to the Contractor's actual labor burden rate, up to a maximum
11 of 60%, will be paid to the Contractor for all base (actual) wages paid to labor and
12 foremen for the specific force account work. No additive will be provided for overtime
13 payments. The labor burden rates will include costs associated with the employee's
14 actual base wages benefits, including Federal Insurance Contributions Act (FICA),
15 unemployment contributions, Social Security and Medicare taxes and company fringe
16 benefits. Company fringe benefits are the actual costs paid to, or on behalf of, workers
17 by reason of health and welfare benefits, pension fund benefits, or other benefits, when
18 such amounts are required by prevailing wage laws generally applicable to the classes of
19 labor employed on the work. The Contractor's actual labor burden rates will be
20 submitted to and approved by the Engineer before beginning the work. When the
21 Contractor cannot verify actual labor burden rates, an amount equal to 35% of the total
22 base (actual) wage paid labor and foremen will be added to the total base wages paid to
23 the Contractor. These percentage additives will be full compensation for overhead,
24 benefits, contingencies and all other costs associated with labor for the specific force
25 account work.

26 **(B) Subsistence and Travel Allowances**

27 The Contractor may receive payment for actual costs paid to, or on behalf of, labor and
28 foremen by reason of subsistence and travel allowances under certain circumstances.
29 When the Contractor is required to mobilize a crew for specific operations, the Engineer
30 may approve reimbursement of subsistence, including meals and overnight lodging, if the
31 specific force account work is determined to be outside of the scope of the original
32 contract and the distance from the Contractor's base location to the project is more than
33 75 miles. Should the Contractor use forces currently working at the location of the
34 specific force account work, the Engineer may approve the payment of subsistence,
35 including meals and overnight lodging, if the work is determined to be outside of the
36 scope of the original contract, the forces currently working at the location has routinely
37 stayed overnight during the life of the project, and the distance from the Contractor's
38 base location to the project is more than 75 miles. The Engineer will approve the mode
39 of travel.

40 Payment will be made to the Contractor for subsistence, including meals and overnight
41 lodging, paid in accordance with the Contractor's usual policy for authorized labor and
42 foremen in direct charge of the specific operations. Subsistence will be limited to the
43 lesser of actual amount paid or the current maximum in-state rate for State employees.
44 Verification of such costs paid to, or on behalf of, labor and foremen will be submitted to
45 the Engineer. If the labor or foremen are partly employed on specific force account work
46 and partly on other work, the amount of subsistence to be reimbursed will be prorated
47 based upon the number of hours worked on the specific force account work during the
48 payroll period.

Section 109

1 (C) Materials

2 For materials authorized and accepted by the Engineer and used, the Contractor will
3 receive the actual cost of such materials, including sales tax and transportation charges
4 paid by him (exclusive of equipment rentals as hereinafter set forth), to which costs 15%
5 will be added. The Contractor will furnish records to the Engineer to verify the quantities
6 of materials used in the specific force account work, prices of the materials, sales tax and
7 costs of transportation for the materials.

8 If materials used in the specific force account work are not specifically purchased for
9 such work but are taken from the Contractor's stock, the Contractor will furnish
10 an affidavit certifying that such materials were taken from his stock, the quantity was
11 actually used in the specific force account work and the price and transportation cost
12 claimed represent the actual cost to the Contractor.

13 (D) Equipment

14 For all equipment authorized by the Engineer to be used on the specific force account
15 work the Contractor will receive rental payment.

16 Hourly rental rates paid for equipment in use that is Contractor owned or rented from
17 another Contractor will not exceed 1/176 of the monthly rate listed in the *Rental Rate*
18 *Blue Book for Construction Equipment* that is current at the time the specific force
19 account work is performed.

20 In determining the hourly rate, the regional adjustment factor and the rate adjustment
21 factor for equipment age, as set forth in the *Blue Book*, will both be applied to the basic
22 rate. An additive payment equal to 100% of the *Blue Book* estimated operating cost per
23 hour will be paid for all hours that equipment is in use. This additive payment will be
24 full compensation for fuel, lubricants, repairs, servicing (greasing, fueling and oiling),
25 small tools and other incidentals.

26 If rental rates for the equipment actually being used in the work are not listed in the *Blue*
27 *Book*, the Contractor will receive the prevailing rental rates being paid for such
28 equipment in the area where the project is located. An additive payment equal to 15% of
29 the prevailing rental rate will be paid for all hours equipment is in use. This additive
30 payment will be full compensation for fuel, lubricants, repairs, servicing (greasing,
31 fueling and oiling), small tools and other incidentals.

32 Hourly rental rates for equipment held in ready as directed by the Engineer will be 50%
33 of the rate paid for equipment in use. An additive payment will not be made for
34 equipment held in ready. When equipment is in use less than 40 hours for any given
35 week and is held in ready as directed by the Engineer, payment for held in ready time will
36 be allowed for up to 40 hours, less hours in use. When payment is made for equipment
37 held in ready as directed by the Engineer, the payment for held in ready time will be
38 allowed for up to 8 hours in a day less hours in use.

39 Hourly rental rates for idle equipment that is held in ready in accordance with
40 Article 104-4 will be paid at 50% of the rate paid for equipment in use. Hourly rental
41 rates for idle equipment held in ready in accordance with Article 104-4 that is rented
42 from a commercial rental agency will be paid in accordance with the invoice rate for the
43 equipment. An additive payment will not be made for idle equipment. When equipment
44 is in use less than 40 hours for any given week and is held in ready as idle equipment in
45 accordance with Article 104-4, payment for idle equipment time will be allowed for up to
46 40 hours, less hours in use. When payment is made for idle equipment held in ready in
47 accordance with Article 104-4, the payment for idle equipment time held in ready will be
48 allowed for up to 8 hours in a day less hours in use.

1 In the event the Contractor does not possess or have readily available such equipment
2 necessary for the performance of the work and such equipment is rented from
3 a commercial rental agency, the Contractor will receive payment based on the approved
4 invoice rate for the equipment.

5 An additive payment equal to 15% of the calculated hourly invoice rate will be paid for
6 all hours equipment is in use. This additive payment will be full compensation for fuel,
7 lubricants, repairs, servicing (greasing, fueling and oiling), small tools and other
8 incidentals. The commercial rental agency cannot be the Contractor or an affiliate of the
9 Contractor.

10 No compensation will be made for the use of equipment not authorized by the Engineer.

11 The Contractor will be reimbursed for the actual transportation costs for equipment that
12 the Contractor is directed to furnish. Such payment will be limited to transportation costs
13 from the nearest source of available equipment. If equipment is not returned to the point
14 of origin, but is transported to another location, transportation costs will not exceed the
15 cost of return to the point of origin. Rental for such equipment will not be paid when the
16 equipment is being transported. The Contractor will furnish records to the Engineer to
17 verify the actual transportation costs for equipment.

18 The Contractor will provide to the Engineer, for approval, a listing of all equipment and
19 attachments to be used in the prosecution of the work. The list will include the
20 manufacturer's name, type, model, serial number and year of manufacture. The list will
21 include the invoice rate for equipment rented from a commercial rental agency. It will be
22 the Contractor's responsibility to verify the age of the equipment in a manner acceptable
23 to the Engineer. Where such verification is not available, the rate adjustment factor used
24 will be for the oldest equipment listed in the *Blue Book*.

25 The above prices and payments will be full compensation for fuel, lubricants, cutting
26 edges, all repairs and all other operating and maintenance costs other than operator's
27 wages.

28 **(E) Owner-Operated Equipment**

29 For all owner-operated equipment authorized by the Engineer to be used on the specific
30 force account work, the Contractor will receive rental payment equal to the existing
31 contract rates with no additive as provided in Subarticles 109-3(A), 109-3(B), 109-3(D)
32 and 109-3(H). When existing contract rates have not been established, the Contractor
33 will submit the proposed rates for the owner-operated equipment with sufficient
34 documentation as deemed necessary by the Engineer for approval.

35 For fully maintained and operated trucks used for the specific force account work, the
36 Contractor will receive rental payment equal to the existing contract rates with no
37 additive as provided in Subarticles 109-3(A), 109-3(B), 109-3(D) and 109-3(H). When
38 existing contract rates have not been established, the prevailing industry rates for fully
39 maintained and operated trucks will be used for the specific force account work with
40 approval of the Engineer.

41 For the purposes of force account work, owner-operated equipment, including fully
42 maintained and operated trucks, will be considered subcontractors. No additional
43 additives other than those allowed under Subarticle 109-3(G) will be allowed.

44 **(F) Miscellaneous**

45 No additional allowance will be made for general superintendence, the use of manually
46 powered tools or other costs for which no specific allowance is herein provided.

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(G) Subcontracting

For administrative costs of the Contractor in connection with approved subcontract work, at any level, and the use of owner-operated equipment, at any level, the Contractor will receive an additive amount in accordance with Table 109-1. The total cost of such subcontracted work will include applicable labor and additive, bond and insurance, materials and equipment costs incurred by the subcontractor; overhead and profit computed in accordance with Subarticles 109-3(A) through 109-3(D), 109-3(F), 109-3(H) and 109-3(I); and costs for owner-operated equipment, including fully maintained and operated trucks in accordance Subarticle 109-3(E). No additional additives will be allowed.

TABLE 109-1	
RATE SCHEDULE FOR SUBCONTRACTING ADDITIVE	
Total Cost of Subcontract Work	Rate Schedule
\$0 - \$10,000	10%
Above \$10,000	\$1,000 + 5% Above \$10,000

(H) Overhead And Profit

An additive payment equal to 10% of the specific force account total will be paid to the Contractor. This specific force account total is exclusive of the portion of the work included with Subarticles 109-3(C), 109-3(E) and 109-3(G). This payment will be full compensation for all costs including but not limited to home office and field overhead, burdens and profit associated with the specific force account work.

An additive payment equal to 10% of the specific force account total for approved subcontract work will be paid to the subcontractor for overhead and profit. This specific force account total for subcontract work is exclusive of the portion of the work included with Subarticles 109-3(C) and 109-3(E). This payment will be full compensation for all costs including but not limited to home office and field overhead, burdens and profit associated with the specific force account subcontracted work. No additional additives will be allowed.

(I) Bond And Insurance

For property damage and liability insurance premiums and bond premiums on the specific force account work the Contractor will receive the actual cost. The Contractor will furnish satisfactory evidence to the Engineer of the rate or rates paid for such insurance and bond.

An annualized composite percentage may be used to determine the cost for bond and insurance. Insurance costs will be limited to the direct costs associated with the specific force account work. The Contractor will furnish satisfactory evidence to the Engineer of the annualized composite percentage for the bond and insurance.

(J) General

The Engineer will maintain the payment records of work performed on a force account basis. The Contractor will compare records of work with the Engineer at the end of each day on which such work is in progress.

Any contention the Contractor may have for an extension in the completion date, intermediate completion date, or intermediate completion time, due to performance of specific force account work will be considered as provided in Article 108-10.

109-4 PARTIAL PAYMENTS**(A) General**

Partial payments will be based upon progress estimates prepared by the Engineer at least once each month on the date established by the Engineer. Partial payments may be made twice each month if in the judgment of the Engineer the amount of work performed is sufficient to warrant such payment. No partial payment will be made when the total value of work performed since the last partial payment, excluding mobilization, amounts to less than \$10,000. Partial payments will be approximate only and will be subject to correction in the final estimate and payment.

Where lump sum items are included in the contract and the applicable section of the Specifications require that fixed percentages of the total amount bid included in partial pay estimates, the Engineer will determine amounts due on partial pay estimate in accordance with the applicable sections of the Specifications.

(B) Prompt Payments

Contractors at all levels, prime, subcontractor, or second tier subcontractor, shall within 7 calendar days of receipt of monies, resulting from the satisfactory completion of work performed, pay subcontractors, second tier subcontractors, or material suppliers. This seven-day period begins upon knowledgeable receipt by the contracting firm obligated to make a subsequent periodic or final payment. This prompt payment requirement will be met if each firm mails the payment to the next level firm by evidence of postmark within the seven-day period. For the purposes of this section, the satisfactory completion of work performed shall exist when a subcontractor, second tier subcontractor or material supplier completes tasks called for in the subcontract and are in conformance with the terms of the Contract as required by the Department. This specification for prompt payment shall be incorporated into each subcontract or second tier subcontract issued for work performed on the project or for services provided.

The Contractor shall not withhold any payments to a subcontractor, second tier subcontractor or material supplier for any claim or action arising outside the current contract with the Department. Notwithstanding the provisions of this section, the Contractor may withhold up to 3% retainage if any subcontractor does not obtain a payment and performance bond for their portion of the work. Additionally, this retainage may be increased to a maximum of 10% where the Contractor and any subcontractor have supplied to the Engineer a satisfactorily executed mutual agreement for an increased amount. If any retainage is held on subcontractors, all retainage shall be released within seven calendar days of satisfactory completion of all work. For release of retainage, satisfactory completion is defined as completion of all physical elements and corresponding documentation as defined in the subcontract, as well as agreement between the parties as to the final quantities for all work performed in the subcontract. The Department will provide internal controls to expedite the determination and processing of the final quantities for the satisfactorily completed subcontract portions of the project.

Failure of any entity to make prompt payment as defined herein may result in the Department:

- (1) Withholding money from the Contractor due for work performed by that entity in the next partial payment until the necessary assurances are made consistent with this specification; or
- (2) Removing an approved Contractor from the prequalified bidders' list or the removal of other entities from the approved subcontractors' list.

Section 109

1 (C) Unbalanced Bids

2 Any excess monies included in an unbalanced bid price that the Department determines
3 to be in excess of a reasonable unit or lump sum bid price for the work, shall be retained
4 by the Department until the last partial payment estimate, at which time these funds will
5 be paid to the Contractor. These retained funds will not be eligible for deposit in any
6 trust account established pursuant to this contract nor for interest for such delay in the
7 payment for the retained portion of the bid price. Partial payment for work performed on
8 an unbalanced bid item shall be at the reasonable unit or lump sum price determined in
9 accordance with this subarticle.

10 For purposes of this subarticle, a reasonable unit or lump sum price will be deemed to be
11 the average of the Engineer's Estimate and the individual balanced bid prices received
12 from the other bidders for the item in question.

13 **109-5 PAYMENT FOR MATERIAL TO BE USED IN THE WORK**

14 (A) Material Delivered on the Project

15 When so authorized by the Engineer, partial payments will be made up to 95% of the
16 delivered cost of materials on hand that are to be incorporated in the work, provided that
17 such materials have been delivered on or in close proximity to the project and stored in
18 an acceptable manner. Material payments will be allowed when 95% of the accumulated
19 costs of unpaid invoices are equal to or greater than \$10,000, materials have been
20 inspected and approved by the Engineer, and the documents listed in Subarticle 109-5(C)
21 have been furnished to the Engineer.

22 (B) Material Stored at Fabricator's Facilities or Contractor's Facilities

23 When so authorized by the Engineer, partial payments will be made up to 95% of the
24 invoiced cost, exclusive of delivery cost, for bulky materials requiring fabrication at
25 an off site location that are durable in nature and represent a significant portion of the
26 project cost, if it has been determined by the Engineer, that the material cannot be
27 reasonably stockpiled in the vicinity of the work. Material payments will be allowed
28 when the materials have been inspected and approved by the Engineer and the documents
29 listed in Subarticle 109-5(C) have been furnished to the Engineer.

30 (C) Required Documents

- 31 (1) Written consent of surety to make such partial payments,
- 32 (2) Bill of Sale from the Contractor to the Department, and
- 33 (3) Copy of invoice from material supplier verifying the cost of the material.

34 (D) General Requirements

35 The partial payments will be made on the conditional basis that the material meets the
36 requirements of the contract and will be incorporated into the project. The Contractor
37 shall reimburse the Department for all partial payments for material paid, but not
38 incorporated into the project.

39 Partial payments for materials on hand will not constitute acceptance, and any faulty
40 material will be rejected even though previous payment may have been made for same in
41 the estimates.

42 Partial payment will not be made for fuel, supplies, form lumber, falsework, or used
43 materials.

44 Partial payments will not be made on seed or any living or perishable plant materials
45 except that when such materials have been planted or otherwise incorporated in the work,
46 payment may be made, not as materials, but as work done as part of a contract item for
47 which a contract unit or lump sum price has been established.

1 Partial payments will not exceed 95% of the contract unit or lump sum prices for the
2 work.

3 **109-6 PAYMENT FOR LEFTOVER MATERIALS**

4 Payment will be made to the Contractor for materials meeting the requirements of the contract
5 that were to have been permanently incorporated into the work or were to remain the property
6 of the Department but due to revisions or elimination of items of work by the Engineer, due to
7 discrepancies in the contract or due to termination of the contract are not used in the work.
8 The Contractor, upon request, will be reimbursed for the verified actual cost of such material
9 delivered to a site designated by the Engineer, including any handling charges less any
10 discount, but in no event shall payment exceed that which would have been made at the
11 contract unit or lump sum price for the completed work.

12 The Contractor shall furnish invoices and cost records to the Engineer to verify the actual cost
13 of materials, handling charges, discounts that were taken and transportation charges. No
14 percentage additive will be added to the verified cost of such material.

15 No payment will be made for loss of anticipated profits and no other payment will be made
16 for leftover materials except as listed above.

17 **109-7 COMPENSATION PAID AT CONTRACT PRICES**

18 Except as provided for by this article, payment for work performed will be made at the
19 contract unit price or the contract lump sum price. Payment shall be made at the adjusted
20 contract unit price, as applicable, when a price adjustment or pay factor is provided for by the
21 contract or as determined by the Engineer in accordance with Article 105-3. In addition to the
22 compensation made at the unit or lump sum price, adjustment in compensation will be made
23 in accordance with Article 109-8. The Contractor shall not be paid for any work performed
24 for which there is not a contract price, nor shall the Contractor receive additional
25 compensation over and above the contract price for work performed or for extra work
26 performed, except for work performed pursuant to an executed supplemental agreement or
27 work performed in accordance with Section 104.

28 **109-8 FUEL PRICE ADJUSTMENTS**

29 Fuel price adjustments will be made to the payments due the Contractor for contract items
30 specified in the contract, or for extra work item specified in the supplemental agreement,
31 when the average terminal price has fluctuated from the Base Index Price contained in the
32 contract. The average terminal price is the average of the Freight on Board (F.O.B.) price for
33 diesel fuel at the terminals in Charlotte, Wilmington and Selma, North Carolina. When the
34 average terminal price fluctuates upward or downward from the Base Index Price, an amount
35 will be added to or deducted from the monies due the Contractor as follows.

36 The current quantity for the specified contract items for which partial payment is made will be
37 multiplied by the respective Diesel Fuel Usage Factor contained in the contract to determine
38 the theoretical diesel fuel usage for each specified contract item. The sum of the theoretical
39 diesel fuel usage for all specified contract items will be multiplied by the algebraic difference
40 between the average F.O.B. price for diesel fuel at the above specified terminals and the Base
41 Index Price contained in the contract to determine the fuel price adjustment to be made on the
42 partial payment estimate.

Section 109

1 The following formula will be used to calculate the appropriate payment or credit on the
2 estimate:

$$S = (A - B)(\sum QF)$$

Where:

- S** = Fuel Price Adjustment for Partial Payment
- B** = Base Index Price
- A** = Average Terminal Price
- Q** = Partial Payment Quantity for Contract Item
- F** = Fuel Factor for Contract Item

3 The average terminal price in effect on the first day of the month in which the partial payment
4 period ends will be used to make payment adjustments for fuel whether or not more than one
5 price fluctuation has occurred within a single partial payment period.

6 The Engineer's estimate of quantities for contract items measured by cross sections shall be
7 used on the various partial payment estimates to determine fuel price adjustments. When the
8 Engineer determines after payment for all or a portion of such contract item that is subject to
9 a fuel price adjustment that the total quantity of work paid to date will be adjusted to reflect
10 more accurate quantity determinations, the Engineer will make a pro rata increase or decrease
11 in the fuel price adjustment proportionate to the adjustment in the total quantity of work paid.
12 The prorated fuel price adjustment for the contract item will be determined by multiplying the
13 cumulative fuel price adjustment made for that contract item for the previous estimate period
14 by the adjusted quantity for that contract item and divided by the total quantity of work paid
15 for the previous estimates for the contract item. Payment for the prorated fuel price
16 adjustment will be made accordingly on the partial payment estimate that includes the
17 adjustment in the quantity of work paid.

18 **109-9 FINAL PAYMENT**

19 Upon completion of the final estimate assembly, the Engineer will notify the Contractor
20 giving the final quantities and the apparent liquidated damages, if any are assessed. After the
21 Contractor reviews the final quantities and submits the documents listed in Article 109-10, the
22 entire sum found to be due after deducting all previous payments and all amounts to be
23 retained or deducted under the requirements of the contract will be paid to the Contractor.

24 **109-10 DOCUMENTS REQUIRED FOR THE PROCESSING OF THE FINAL** 25 **ESTIMATE**

26 Before the processing of the final estimate, the following documents shall have been
27 submitted to and accepted by the Engineer.

28 **(A)** Statement of Consent of Surety on the contract bonds for payment of money due the
29 Contractor.

30 **(B)** Affidavit of the Contractor that all obligations and debts arising out of the construction
31 have been satisfied or affidavit that shall include a list of obligations not satisfied.

32 **(C)** Written notice that the Contractor has no request for any extension in the completion date
33 or any adjustment in compensation from that shown in the final estimate or in lieu thereof
34 written notice presenting all request for adjustment of the final estimate setting forth full
35 justification for such requests.

36 **(D)** Any other documents that are required by the contract such as reports, statements and
37 other information necessary for compliance with applicable labor regulations of the
38 FHWA.

1 Submission of false information in the documents required by this section shall be a basis for
2 disqualifying the Contractor from further bidding in accordance with Article 102-15. If the
3 Contractor fails to submit the required documentation within the timeframe specified by the
4 Department, the Department may consider the Contractor to be nonresponsive and may
5 process the final estimate.

6 **109-11 INTEREST ON FINAL PAYMENT**

7 Should final payment on a project not be made within 120 calendar days after the project final
8 acceptance date, interest, at the average rate earned by the State Treasurer on the investment
9 within the State's Short Term Investment Fund during the month preceding the date interest
10 becomes payable, will be paid to the Contractor on the final payment for the period beginning
11 on the 121st day after final acceptance and extending to the date the final estimate is paid,
12 provided that the documents required by Article 109-10 have been submitted within 30 days
13 of the mailing of the notification outlined in Article 109-9. In the event the Contractor fails to
14 submit the required documents within the stipulated 30 days, and the final estimate is not paid
15 until 120 calendar days following final acceptance of the project, the number of days on
16 which interest accrues will be reduced by the number of days in excess of 30 that the
17 Contractor requires to submit the documents.

18 **SECTION 150**
19 **MAINTENANCE OF TRAFFIC**

20 The Contractor will be required to maintain traffic within the limits of the project, including
21 all existing roadways that cross or intersect the project, unless otherwise provided in the
22 contract or approved by the Engineer. Traffic shall be maintained from the time the
23 Contractor begins work on the project site until acceptance of the project, including any
24 periods during which the Contractor's operations are suspended, unless otherwise provided for
25 in the contract or approved by the Engineer. The Contractor shall conduct his work in a safe
26 manner that will create a minimum amount of inconvenience to traffic.

27 The Contractor shall be responsible for maintaining in a safe, passable and convenient
28 condition, such part or parts of existing roads as are being used by him to maintain traffic
29 within the limits of the project from the time the Contractor begins work on the project until
30 acceptance of the project. As an exception to the above, the Department will be responsible
31 for the removal of ice and snow from all portions of the project open to traffic.

32 Whenever it is necessary to use traffic control devices as shown in the contract, as determined
33 by the Engineer, or to conform to this section, the work of furnishing, erecting, operating,
34 maintaining, covering, relocating and removing traffic control devices shall be in accordance
35 with Division 11 and 12.

DIVISION 2 EARTHWORK

SECTION 200 CLEARING AND GRUBBING

200-1 DESCRIPTION

Perform the work of clearing and grubbing in all wooded areas between the construction limits. Perform the work of clearing and grubbing in all non-wooded areas between the construction limits and the limits of the project right of way or in easements shown on the project plans where seeding and mulching, sprigging, sodding or other work as indicated.

“Clearing” is defined as the cutting, removal and satisfactory disposal of all wooded vegetation and debris.

“Grubbing” is defined as the complete removal and satisfactory disposal of all grassy vegetative matter, root mat, ball and root, topsoil material high in organic content and surface debris.

200-2 MATERIALS

Refer to Division 10.

200-3 CONSTRUCTION METHODS

Perform the following as part of the work of clearing and grubbing:

- (A) Remove and dispose of crops, weeds and other annual growth;
- (B) Remove and dispose of surface debris such as fences, steps, walls, chimneys, column footings, other footings, foundation slabs, basements, other foundation components, signs, junked vehicles and other rubble and debris;
- (C) Fill holes and depressions that exist or are created;
- (D) Cut off and plug at the right-of-way or construction limits any private water or sewer line intercepted during the construction of the project;
- (E) Cut off and remove from the right-of-way or construction area any septic tank or portion thereof encountered within the right-of-way or construction area during the construction of the project; and
- (F) Remove materials in wetland areas to a depth of one foot below existing ground to be measured in accordance with Section 225.

Perform clearing and grubbing operations sufficiently before grading operations to prevent any debris from interfering with the excavation or embankment operations.

In environmentally sensitive areas shown on the original plans or permit drawings, perform grubbing operations no more than 7 calendar days before beginning continuous grading operations.

Perform all work under this section to minimize soil erosion and in accordance with Article 107-12. Coordinate the work with other operations such that no more than 17 acres of exposed, erodible surface area will be accumulated at any one time by the clearing and grubbing operation until erosion control measures are provided. Install temporary or permanent erosion control measures as soon as clearing and grubbing or land disturbing activities begin. Perform such erosion control work, temporary or permanent, as needed to minimize erosion resulting from clearing and grubbing operations.

Section 200

1 The Contractor may request an increase in the accumulated acres exposed by clearing and
2 grubbing. If approved, establish and maintain such erosion control measures as needed.

3 Failure on the part of the Contractor to perform the required erosion control measures will be
4 just cause for the Engineer to direct the suspension of clearing and grubbing operations in
5 accordance with Article 108-7. The suspension will be in effect until such time as the
6 Contractor has satisfactorily performed the required erosion control work. If the Contractor
7 fails to perform the directed work within a reasonable length of time, the Engineer may have
8 the work performed in accordance with Article 105-16.

9 **200-4 CLEARING**

10 Perform clearing within the limits established by the clearing method required by the plans
11 and as directed.

12 The Engineer will designate all areas of growth or individual trees that shall be preserved due
13 to their desirability for landscape or erosion control purposes. When the trees to be preserved
14 are located within the construction limits, they will be shown in the plans or designated by the
15 Engineer.

16 Trim or cut branches of trees that overhang the roadbed, utility easements or obstruct sight
17 distances and that are less than 16 ft above the elevation of the finished grade so as to not
18 endanger the health of the tree.

19 In embankment areas where the depth of the embankment measured under the roadbed
20 exceeds 6 ft in height, cut sound trees at a height of not more than 6" above natural ground.
21 When trees are to be cut outside the construction limits and the Engineer has designated that
22 the area is not to be grubbed, cut the trees reasonably close to the natural ground surface. Cut
23 trees to approximately 6" above low water level in swamp areas.

24 At a bridge site, clear the entire width of the right of way beginning at a station 3 ft back of
25 the beginning extremity of the structure and ending at a station 3 ft beyond the ending
26 extremity of the structure.

27 Prevent limb, bark or root injuries to trees, shrubs or other types of vegetation that are to
28 remain growing and prevent damage to adjacent property. Repair scarred areas in accordance
29 with generally accepted horticultural practice. Where plants are damaged by any construction
30 operations to such an extent as to destroy their value for shade or other landscape purposes,
31 cut and dispose of them.

32 **200-5 GRUBBING**

33 Perform grubbing on all areas cleared, with the following exceptions:

34 (A) In embankment areas, when the depth of embankment measured under the roadbed
35 exceeds 6 ft in height, cut off sound stumps not more than 6" above the existing ground
36 level and do not grub. Remove unsound or decayed stumps to a depth of approximately
37 2 ft below the natural ground surface.

38 (B) When authorized, leave stumps outside of construction limits in place. Cut such stumps
39 off reasonably close to the natural ground surface.

40 (C) Cut off stumps in swamp areas to approximately 6" above low water level and do not
41 grub.

42 (D) Do not grub in areas where waste or unsuitable material is to be deposited unless such
43 areas are to become a part of a future roadway.

44 (E) Grub all areas where piles are to be driven regardless of fill height.

45 (F) Fill all holes and other depressions within the areas between the construction limits and
46 the limits of clearing and grubbing. Bring all areas to a uniform contour where later
47 mowing operations will take place.

1 200-6 DISPOSITION OF TIMBER, STUMPS AND DEBRIS

2 The property owner will have no right to use or reserve for their use any timber on the project.
3 All timber cut during the clearing operations shall become the property of the Contractor and
4 shall be removed from the project or shall be satisfactorily disposed of as provided
5 hereinafter.

6 Do not cut any trees and vegetation beyond the clearing limits established. Do not cut any
7 trees and vegetation that is to be preserved for landscape or erosion control purposes as shown
8 in the plans and permit drawings.

9 Remove from the project and properly dispose of all vegetation, roots, stumps, tree laps, limbs
10 and timber remaining on the project by a satisfactory method.

11 When vegetation is disposed of by burning, burn so as to prevent injury to property within or
12 outside of the right of way. Comply with all Federal, State and local laws, ordinances and
13 regulations when burning. Secure all necessary burning permits. Perform all burning under
14 the constant care of a competent watchman. Do not allow smoldering or dense smoke to
15 occur during burning.

16 Before trees or vegetation are disposed of in locations off the right of way and out of sight of
17 the project, furnish the Engineer with verification that the site is permitted. If required, file
18 an approved reclamation plan and furnish a written release from the property owner, or his
19 authorized agent, granting the servitude of his lands.

20 If it is not burned, dispose of all debris including vegetation in accordance with Section 802.

21 200-7 SELECT TREE REMOVAL

22 When the contract includes the item of *Select Tree Removal* and the work of clearing and
23 grubbing has been completed to the original clearing limits, the Engineer may elect to have
24 select trees removed from the project. Trees removed in this manner shall have an average
25 cross section diameter of at least 4 inches at a point 2 feet above the ground level.

26 Completely remove the select trees including the root ball and properly backfill unless
27 otherwise directed.

28 200-8 MEASUREMENT AND PAYMENT

29 *Clearing and Grubbing* will be paid on a lump-sum basis and no measurement will be made
30 of any clearing and grubbing performed within the limits originally staked and within the
31 right of way or easements shown on the original plans.

32 *Supplementary Clearing and Grubbing* that is directed by the Engineer and is performed on
33 areas outside the limits originally staked or beyond the limits of the right of way or easements
34 or within environmentally sensitive areas shown on the original plans will be measured and
35 paid at the contract unit price per acre. All measurement of clearing and grubbing will be
36 made horizontally.

37 Once the root mat is removed, material that consists predominately of soils will be measured
38 and paid in accordance with Section 225.

39 Materials used to fill depressions in accordance with Subarticle 200-5(F) will be measured
40 and paid in accordance with Sections 225 or 230, depending on the source of the material.

41 When the Contractor is required to furnish borrow sources, material sources or waste areas, or
42 when the Engineer permits the Contractor to obtain borrow or deposit waste on any area
43 within the right of way instead of borrow and waste areas which were to have been furnished
44 by the Contractor, no measurement of clearing and grubbing will be made for such areas.

45 When an increase in accumulated acres exposed by clearing and grubbing is requested by the
46 Contractor and approved by the Engineer, no payment will be made for the temporary seeding
47 and mulching required by the increase in accumulated exposed acres.

Section 205

- 1 *Select Tree Removal* will be measured and paid as the actual number of select trees
- 2 satisfactorily removed from the project.
- 3 Work performed in cleaning up non-wooded areas between the construction limits and the
- 4 limits of the project right of way or easements shown in the plans; work performed in the
- 5 dressing up of areas between the construction limits and the clearing limits; and the removal
- 6 of weeds, vines, plant stalks, loose rock and small scattered trees will be incidental to the
- 7 work of clearing and grubbing.
- 8 Where plants are damaged by construction operations, the work to cut and dispose of them
- 9 will be incidental to the work of clearing and grubbing.
- 10 Payment will be made under:

Pay Item	Pay Unit
Clearing and Grubbing	Lump Sum
Supplementary Clearing and Grubbing	Acre
Select Tree Removal	Each

SECTION 205
SEALING ABANDONED WELLS

205-1 DESCRIPTION

Seal abandoned wells at locations shown in the contract or as directed. Perform all work in accordance with NCDENR requirements.

205-2 CONSTRUCTION METHODS

- Use a well contractor certified by the State of North Carolina to perform abandonment.
- Seal each well before clearing and grubbing the well site. Check the well from land surface to the entire depth of the well before it is sealed to ensure freedom from obstructions that may interfere with sealing operations. Before sealing, place chlorine in the well in sufficient quantities to produce a chlorine residual of at least 100 milligrams per liter in the well.
- All casing and screen materials may be salvaged except casing that is cemented in place. In the case of gravel-packed wells in which the casing and screens have not been removed, perforate the casing opposite the gravel pack at intervals not exceeding 10 ft.
- Completely fill bored wells with cement grout or dry clay compacted in place. Completely fill wells constructed in unconsolidated formations with cement grout by introducing it through a pipe extending to the bottom and raising it as the well is filled. Fill wells constructed in consolidated rock formations or that penetrate zones of consolidated rock to at least 5 ft below the top of the consolidated rock with sand, gravel or grout opposite the zones of consolidated rock. Fill the remainder of the well with cement grout.

Complete a certified well abandonment record (Form GW-30) and submit to the Engineer.

205-3 MEASUREMENT AND PAYMENT

Sealing Abandoned Wells will be measured and paid in units of each for the actual number of wells acceptably sealed. Work includes, but is not limited to, chlorinating the well before sealing; perforating the well casing; filling the well with cement grout, dry clay, sand or gravel; and furnishing all necessary records.

Payment will be made under:

Pay Item	Pay Unit
Sealing Abandoned Wells	Each

Section 215

1 Do not disturb any fencing, outbuilding or other obstruction that are entirely clear of the right
2 of way unless otherwise indicated in the plans or in the contract.

3 Conform to all applicable safety codes pertaining to the work, secure all permits that may be
4 required and pay all fees in connection therewith.

5 **210-3 UTILITIES**

6 Make all necessary arrangements with utility companies for the disconnecting of all services
7 and the removal of and recovery by them of all meters, telephones and any other utility
8 facilities or equipment owned by them. Arrange for and actually effect the disconnecting and
9 closing of water and sewer connections to buildings, including but not limited to any work
10 that shall be done in addition to that normally done by the utility company, in conformity with
11 all applicable codes and regulations of the local Boards of Health. Pay for all costs incurred
12 in connection with the above work. All refunds or deposits that may become due as a result
13 of the disconnection of service and the returning of equipment or facilities to any utility
14 company become the property of the Department.

15 **210-4 DISPOSAL**

16 Unless otherwise indicated in the contract, all materials recovered during demolition become
17 the property of the Contractor to remove from the project. Disposal by burning is permitted,
18 subject to all other applicable sections of these *Standard Specifications* and all State and local
19 ordinances.

20 Dispose of materials and debris in accordance with Section 802.

21 **210-5 MEASUREMENT AND PAYMENT**

22 There will be no direct payment for demolishing the buildings and appurtenances listed in the
23 contract. Payment for this work will be included in the contract lump sum price for *Clearing*
24 *and Grubbing* in accordance with Article 200-8.

25 Where underground storage tanks are indicated, there will be no direct payment for the
26 closure or assessment, as payment at the contract lump sum price for *Clearing and Grubbing*
27 will be full compensation for all costs of such closure or assessment.

28 As an exception to the above, when the description of the work covered by a particular
29 building demolition item does not contain information concerning the presence of asbestos
30 material or underground storage tanks and the asbestos material or underground storage tanks
31 are discovered after the opening of bids for the project, the Engineer may have the work
32 performed by others or the cost of removal and disposal of such asbestos material or
33 underground storage tanks will be paid in accordance with Article 104-7.

34 **SECTION 215**

35 **REMOVAL OF EXISTING BUILDINGS**

36 **215-1 DESCRIPTION**

37 Remove and dispose of all buildings, building components and appurtenances indicated in the
38 contract.

39 **215-2 CONSTRUCTION METHODS**

40 Buildings may be removed intact, removed in sections or demolished. Dispose of resulting
41 material and debris. All materials resulting from the removal of buildings, except such
42 materials as may be the property of utility companies providing service to the building,
43 become the property of the Contractor to dispose of or use or sell by him as his own property.

1 Provide all permits and dispose of all contaminated material encountered in connection with
2 the work. Before removal of any building, comply with the notification requirements of
3 40 CFR Part 61, Subpart M, that applies to asbestos. Give notification to the North Carolina
4 Department of Health and Human Services, Division of Public Health Epidemiology Branch
5 and/or the appropriate county agency when the county performs enforcement of the Federal
6 Regulation. Submit a copy of the notification to the Engineer before the building removal.

7 Perform removal and disposal of asbestos in accordance with 40 CFR. Comply with all
8 Federal, State and local regulations when performing building removal; asbestos removal and
9 disposal; and UST removal and contaminated material disposal. Any fines resulting from
10 violations of any regulation are the sole responsibility of the Contractor and the Contractor
11 agrees to indemnify and hold harmless the Department against any assessment of such fines.

12 The Department will perform asbestos assessments and abatement for building items
13 identified in the contract. Copies of this report may be obtained through the
14 Division Right-of-Way Agent. When a building has had or will have asbestos removed and
15 the Contractor elects to remove the building such that it becomes a public area, the Contractor
16 is responsible for any additional costs incurred including final air monitoring.

17 Before removal of any UST, comply with the notification requirements of
18 40 CFR Part 280.71(a). Give notification to the appropriate regional office of NCDENR,
19 Division of Waste Management, UST Section. Submit a copy of the notification to the
20 Engineer before the removal of the UST.

21 Permanently close UST systems by removal and disposal in compliance with the regulations
22 set forth in 40 CFR Part 280.71 and 15A NCAC 2N and any applicable local regulations.
23 Assess UST sites at closure for the presence of contamination as required in
24 15A NCAC 2N .0803 and as directed by the appropriate Regional Office of the Division of
25 Waste Management. Remove and dispose of UST systems and contents in a safe manner in
26 conformance with *American Petroleum Institute Bulletin 1604*, Removal and Disposal of
27 Used Underground Petroleum Storage Tanks, Chapters 3 through 6. As an exception to these
28 requirements, the filling of the tank with water as a means of expelling vapors from the tank
29 as described in Section 4.2.6.1 of *American Petroleum Institute Bulletin 1604*, will not be
30 allowed. Disposition of any contaminated material associated with UST will be made in
31 accordance with Article 107-26.

32 Completely clear from the right of way all buildings, including sheds, outbuildings or other
33 obstructions as indicated in the contract. Remove all shelters, porches, roofed areas and other
34 appurtenances that are attached to the building. Remove steps, chimneys, column footings,
35 other footings, foundation slabs, basements or other foundation components shall be removed.

36 Do not disturb any fencing, outbuildings or other obstruction, that is entirely clear of the right
37 of way unless otherwise indicated in the plans or in the contract.

38 Conform to all applicable safety codes pertaining to the work and secure all permits that may
39 be required and pay all fees in connection therewith.

40 **215-3 UTILITIES**

41 Make all necessary arrangements with utility companies for the disconnecting of service and
42 the removal of and recovery by them of all meters, telephones or any other utility facilities or
43 equipment owned by them. Arrange for and effect the disconnecting and closing of water and
44 sewer connections to the buildings, including but not limited to any work that shall be done in
45 addition to that normally done by the utility company, in conformity with all applicable codes
46 and regulations of the local Boards of Health. Pay for all costs incurred in connection with
47 the above work. All refunds or deposits that may become due as a result of the disconnection
48 of service and the returning of equipment or facilities to any utility company becomes the
49 property of the Department.

Section 220

1 **215-4 DISPOSAL**

2 Unless otherwise indicated in the contract, all materials recovered during demolition become
3 the property of the Contractor to remove from the project. Disposal by burning is permitted,
4 subject to applicable sections of the *Standard Specifications*, State and local ordinances.

5 Dispose of materials and debris in accordance with Section 802.

6 **215-5 MEASUREMENT AND PAYMENT**

7 There will be no direct payment for removing the buildings listed in the contract. Payment for
8 this work will be included in the contract lump sum price for *Clearing and Grubbing*.

9 Where underground storage tanks are indicated in the contract, there will be no direct
10 payment for the assessment or closure. Payment for this work will be included in the contract
11 lump sum price for *Clearing and Grubbing*.

12 As an exception to the above, when the description of the work covered by a particular
13 building removal item does not contain information concerning the presence of asbestos
14 material or UST and the asbestos material or UST are discovered after the opening of bids, the
15 Engineer may have the work performed by others or the cost of removal and disposal of such
16 asbestos material or UST will be paid in accordance with Article 104-7.

17 **SECTION 220**
18 **BLASTING**

19 **220-1 DESCRIPTION**

20 Use blasting as needed to excavate, break up or remove rock, construct stable rock cut slopes
21 and for other approved reasons. This section applies to all types of blasting including
22 production, controlled, cushion, trim, trench and secondary blasting except blasting adjacent
23 to highway structures. See Article 410-9 for blasting adjacent to highway structures. Provide
24 blasting plans, blast monitoring and post-blast reports as necessary or required. Perform
25 blasting in accordance with the contract, accepted submittals and as directed. Use
26 a prequalified Blasting Contractor for blasting.

27 **220-2 MATERIALS**

28 Refer to Division 10.

Item	Section
Coarse Aggregate	1005

29 Use coarse aggregate (standard size No. 67 or 78M) for stemming.

30 **220-3 CONSTRUCTION METHODS**

31 Notify the Engineer and all occupants and owners of residences, businesses and utilities near
32 where blasting will occur of the intention to use explosives. Inform the Engineer, occupants
33 and owners of blasting at least 48 hours before each blast. When blasting in the vicinity of
34 an open travelway, provide traffic control in accordance with the contract and Section 1101.

35 Control blasting to avoid endangering lives or damaging property. The Contractor is
36 responsible for any injuries and damages due to blasting in accordance with Article 107-11
37 except for damage to wells and springs, unless the Contractor did not use reasonable care to
38 prevent such damage. Exercise the utmost care when blasting near sensitive environmental or
39 populated areas, urban or sensitive communities or historical structures. Comply with all the
40 latest applicable Federal, State and local codes, laws and regulations, as well as professional
41 society standards for the storage, transportation and use of explosives. Keep a copy of all
42 regulations on site and in case of conflict, the more stringent applies.

1 The Blaster-in-Charge has authority over the handling, use and security of explosives and is
2 responsible for designing, planning, coordinating, supervising and monitoring blasting.
3 Assign a Blaster-in-Charge to the project that has at least 5 years of experience with blasting
4 similar to that anticipated for the project. Use a Blaster-in-Charge approved as a Blaster-in-
5 Charge (key person) for the Blasting Contractor. The Blaster-in-Charge or designated
6 Assistant Blaster-in-Charge shall be on site during blasting.

7 When blasts will be within 1,000 ft of a utility, house, residence, building, business or any
8 other structure, a blasting plan and blast monitoring that meet Subarticles 220-3(B)
9 and 220-3(C) are required. Otherwise, provide a blasting plan and monitor blasts as needed.

10 **(A) Vibration and Air Overpressure Limits**

11 Define “peak particle velocity” (PPV) as the maximum ground vibration velocity
12 measured in any direction. Design blasts so the PPV at any utility or structure does not
13 exceed the “Alternative Blasting Level Criteria” from Appendix B of the *U.S. Bureau of*
14 *Mines Report of Investigations 8507*. Design blasts so the maximum air-overpressure at
15 any structure does not exceed 133 dB (linear).

16 If the PPV or air overpressure limits are exceeded at any utility or structure in any
17 direction from blasts, the Engineer may suspend blasting until the post-blast report is
18 reviewed and a new or revised blasting plan is accepted.

19 **(B) Blasting Plan**

20 When required, submit the proposed blasting plan signed by the Blaster-in-Charge for all
21 blasting for acceptance. Acceptance of this plan does not relieve the Contractor of
22 responsibility and liability for blasting in accordance with the contract.

23 Submit 2 copies and a PDF copy of the blasting plan at least 30 days before starting
24 blasting. Do not deliver explosives to the project site or begin blasting until a blasting
25 plan is accepted. Submit one copy to the Resident Engineer and the other copy and PDF
26 copy to the appropriate Geotechnical Engineering Unit regional office. Provide detailed
27 project specific information in the blasting plan that includes the following:

- 28 (1) Work procedures and safety precautions for storage, transportation, handling and
29 detonation of explosives;
- 30 (2) Explosive products and devices for dry and wet blast holes including explosives,
31 primers and detonators with MSDS;
- 32 (3) Drilling equipment including methods for maintaining blast hole alignment;
- 33 (4) Typical plan, profile and sectional views for blasting showing blasting limits, blast
34 hole diameters, depths, inclinations and spacing, burden, subdrill depths and
35 minimum and maximum charge per delay;
- 36 (5) Initiation and delay methods and delay times;
- 37 (6) Equipment and procedures for blast monitoring with calibration certificates dated
38 within one year of submittal date; and
- 39 (7) Post-blast report format.

40 If alternate blasting procedures are proposed or necessary, a revised blasting plan
41 submittal may be required. If blasting deviates from the accepted submittal without prior
42 approval, the Engineer may suspend blasting until a revised plan is accepted.

Section 220

1 (C) Blast Monitoring

2 If necessary or required, monitor blasts using seismographs capable of measuring air
3 overpressure and vibration in the vertical, longitudinal and transverse directions. At
4 a minimum, monitor vibration and air-overpressure at the closest utility or structure to
5 each blast and the closest utility or structure in the direction of each blast in accordance
6 with the accepted blasting plan. Include the following in post-blast reports for each blast
7 monitoring location:

8 (1) Type, identification and specific location of seismograph,

9 (2) Distance and direction from blast,

10 (3) PPV in each direction and peak vector sum, and

11 (4) Maximum air overpressure level.

12 (D) Blasting Requirements

13 Before beginning drilling, a pre-blast meeting may be required to discuss the blasting and
14 if applicable, blast monitoring. Schedule this meeting after any blast plans have been
15 accepted. The Resident or District Engineer, Roadway Construction Engineer,
16 Geotechnical Operations Engineer, Contractor and Blaster-in-Charge will attend this pre-
17 blast meeting.

18 Drill and blast in accordance with the contract and if applicable, the accepted blast plan.
19 Use explosives in accordance with all applicable government regulations, professional
20 society standards and manufacturer guidelines and recommendations. Do not allow
21 ammonium nitrate fuel oil (ANFO) to leach into bodies of water.

22 Before blasting for excavations, remove all overburden material along top of excavations
23 for at least 30 ft beyond blasting or rock limits, whichever is less. Inspect any free faces
24 to ensure adequate burden. Drill blast holes within 3" of plan location and maintain hole
25 alignment when drilling.

26 Cover blast holes after drilling to prevent unwanted backfill and identify and mark each
27 blast hole with hole number and depth. Blast holes shall be free of obstructions the entire
28 depth. Load blast holes without dislodging material or caving in hole walls. Stem blast
29 holes 5" or larger in diameter with No. 67 stone and blast holes smaller than 5" in
30 diameter with No. 78M stone. Do not stem blast holes with drill cuttings.

31 Contain flyrock within construction limits. Use matting when blast monitoring or traffic
32 control is required. Soil cover may be used instead of matting, if approved. If flyrock
33 occurs outside the construction limits, the Engineer may suspend blasting until the post-
34 blast report is reviewed and a new or revised blasting plan is accepted. When traffic
35 control is required for blasting, have equipment standing by to remove material that
36 interferes with traffic flow. Check for misfires immediately after each blast before
37 signaling all clear.

38 Remove all loose, hanging and potentially dangerous material from rock cut slopes by
39 scaling. The Contractor is responsible for the stability of rock cuts. If rock cuts are
40 damaged during blasting, stabilize cuts to the satisfaction of the Engineer. Resume
41 drilling only after scaling is complete. Adjust blast hole alignments to account for any
42 drift occurring in preceding drilling or lifts.

43 Define "secondary blasting" as blasting to reduce the size of naturally occurring boulders
44 or those resulting from initial blasting. Use an approved method for secondary blasting
45 consisting of small explosive charges in small diameter blast holes. Define
46 "mudcapping" as placing unconfined explosive charges in contact with rock without blast
47 holes and covering charges with mud. Do not use mudcapping for blasting.

(E) Post-Blast Report

Submit 2 copies and a PDF copy of a post-blast report within 3 days of each blast or before the next blast, whichever is sooner. Provide post-blast reports signed by the Blaster-in-Charge that include the following:

- (1) Material data information about explosive products and devices including explosives, primers and detonators;
- (2) Scaled blast drawings with cross sections showing blasting limits, blast hole diameters, depths, inclinations and spacing, burden, subdrill depth, free face location and any joints, bedding planes, weathered zones, voids or other significant rock structure information;
- (3) Loading pattern diagram with location and amount of each type of explosive including primers and detonators;
- (4) Locations and depths of stemming, column heights and maximum charge per delay for each type of loading;
- (5) Delay and initiation diagram showing delay pattern, sequence and times;
- (6) Results and effectiveness of the blast and any proposed changes to subsequent blasting;
- (7) If applicable, blast monitoring results; and
- (8) Blast damage report when necessary.

(F) Blast Damage Report

If damage occurs from blasting, notify the Engineer immediately and submit a blast damage report with the post-blast report that includes the following:

- (1) Property owner's and injured person's, if any, names, addresses and telephone numbers;
- (2) Details and description of property damage and injury, if any, with photographs or video; and
- (3) Any associated tort claims, complaint letters and other applicable information.

220-4 MEASUREMENT AND PAYMENT

No direct payment will be made for blasting including blasting plans, blast monitoring, post-blast reports, scaling and stabilizing rock cuts.

No direct payment will be made for blasting for roadway excavation. Blasting for roadway excavation will be incidental to the contract unit price for *Unclassified Excavation* in accordance with Article 225-7 or the lump sum price for *Grading* in accordance with Article 226-3.

No direct payment will be made for blasting for any pipe, utility or foundation excavation. Blasting for these items will be incidental to the compensation for the excavation. Where no direct payment is made for excavation, blasting will be incidental to the work and no separate payment will be made for blasting.

SECTION 225 ROADWAY EXCAVATION

225-1 DESCRIPTION

Excavate, place and compact or satisfactorily dispose of all materials encountered within the limits of the work necessary for the construction of the roadway that are not to be removed under another contract item.

Section 225

- 1 Perform all excavation in conformity with the lines, grades and cross sections shown in the
2 plans or established by the Engineer.
- 3 Use care not to cause instability or displacement of the underlying or adjacent materials
4 during construction. The Engineer reserves the right to effect the removal from the grading
5 operation of any equipment that is causing instability or displacement of underlying or
6 adjacent materials to the detriment of the section being constructed.
- 7 Construct false sumps in accordance with the details in the plans and at the locations shown in
8 the plans or at other locations as directed.
- 9 Define "Unclassified Excavation" as all material excavated under this section, regardless of
10 its nature or composition, except for undercut excavation and material directed to be removed
11 beyond the limits of the original slope stakes.
- 12 Define "Undercut Excavation" as the excavation, placement and compaction and/or
13 satisfactory disposal of materials removed from a location below the finished graded roadway
14 cross section, except for the following:
- 15 (A) Rock in the bottom of roadway cuts that has been excavated one foot or less below the
16 roadbed and ditches, or
- 17 (B) In cut areas, excavation removed below the outside slopes of roadway ditches.
- 18 **225-2 EROSION CONTROL REQUIREMENTS**
- 19 Install erosion control measures as required by the plans before any kind of land-disturbing
20 activity.
- 21 Unless otherwise required by the plans, conduct operations so that final slopes are completely
22 graded in a continuous operation and permanently seeded and mulched in accordance with
23 Article 107-12.
- 24 Should the Contractor fail to comply with the requirements specified above within the time
25 frames established by the Sedimentation and Pollution Control Act, the Contractor shall
26 perform temporary seeding and mulching on any exposed areas at his own expense.
- 27 When the Contractor fails or neglects to coordinate grading with the permanent seeding and
28 mulching operation, the Engineer may suspend the Contractor's grading operation in
29 accordance with Article 108-7 until the work is coordinated in a manner acceptable to the
30 Engineer. Failure to perform the directed work may result in the Engineer having the work
31 performed in accordance with Article 105-16.
- 32 **225-3 UNCLASSIFIED EXCAVATION**
- 33 Use all suitable material removed from the excavation as far as practicable in the formation of
34 embankments, subgrades, shoulders and places indicated in the plans or directed.
- 35 The wasting of suitable material removed as part of unclassified excavation before the
36 completion of embankments is permitted where the Contractor executes a supplemental
37 agreement documenting that he agrees to the following:
- 38 (A) Provide and incorporate into the project any material required to complete the project up
39 to the volume wasted. Bear all additional costs for providing and incorporating this
40 material into the work, including engineering costs, and
- 41 (B) Provide suitable replacement material either wasted from the project or approved borrow
42 material, at the Contractor's option, and
- 43 (C) Present no claim for any time arising from the wasting of excess unclassified excavation
44 or for having to replace material wasted from the project that the Department may require
45 to complete the work, and

1 (D) Waive rights to request additional compensation with regard to wasting unclassified
2 excavation under the compensation requirements of Section 104 as a result of wasting
3 suitable unclassified excavation and providing replacement material required to complete
4 the work except when unclassified excavation is a major contract item, as defined in
5 Section 101, and when unclassified excavation underruns by more than 25%.

6 Where the work required to complete the project is so phased by the plans to preclude using
7 suitable unclassified excavation, the Contractor will be permitted to waste suitable
8 unclassified excavation without having to execute the above required supplemental
9 agreement.

10 Furnish disposal areas for the unsuitable material except where the Engineer permits or directs
11 the use of such material in the widening or flattening of fill slopes. The Engineer will
12 designate materials that are unsuitable.

13 Where suitable materials containing excessive moisture are encountered above grade in cuts,
14 construct above grade ditch drains before the excavation of the cut material when such
15 measures are necessary to provide proper drainage.

16 Upon execution of a supplemental agreement containing conditions listed below, the
17 Contractor may waste suitable unclassified excavation and replace it with approved borrow
18 material.

19 (A) Replace with approved borrow material all suitable unclassified excavation that was
20 wasted.

21 (B) Bear all additional costs associated with the wasting of the unsuitable unclassified
22 excavation and the replacing of it with borrow material, including any additional
23 engineering costs to the Department.

24 (C) The execution of a supplemental agreement allowing the Contractor to waste suitable
25 unclassified excavation and replace it with approved borrow material bars the Contractor
26 from any claim for any time extensions related to the wasting and replacement operation
27 described in the agreement.

28 (D) The Contractor specifically waives his rights to request additional compensation with
29 regard to wasting unclassified excavation under the compensation requirements of
30 Section 104 as result of substituting suitable borrow material and wasting suitable
31 unclassified excavation.

32 Where the contract includes earth shoulder construction, stockpile suitable surplus material
33 for use in the shoulders. To the extent possible, salvage topsoil from within the limits of the
34 slope stake lines and store in stockpiles. Before the topsoil is removed, clear the areas of all
35 weeds, brush, stumps, stones and other debris. Remove the topsoil from only such areas and
36 to only such depths as required by the contract or as directed. Exercise care to avoid mixing
37 subsoil or other unsuitable material with the topsoil. Stockpile an adequate quantity of
38 material to construct the proposed shoulder before wasting any suitable surplus material.
39 Locate the stockpiles along the project at approved locations. Neatly dress each stockpile,
40 when completed. Perform temporary or permanent seeding on the stockpiles where directed
41 or when necessary to prevent erosion. Remove and dispose of any surplus material remaining
42 in the stockpile after the shoulders are completed as provided below for waste matter.

43 Dispose of waste material in accordance with Section 802.

44 Uniformly round the intersection of slopes with natural ground surfaces, including the
45 beginning and ending of cut slopes, as shown in the plans. Concurrent with the excavation of
46 cuts, construct intercepting berm ditches or earth berms along and on top of the cut slopes at
47 locations shown in the plans or as designated. Finish all slopes to reasonably uniform
48 surfaces acceptable for seeding and mulching operations. Leave no rock or boulders in
49 place that protrude more than one foot within the typical section cut slope lines.

Section 225

- 1 Clean all rock cuts of loose and overhanging material. Remove all protruding roots and other
2 objectionable vegetation from the slopes.
- 3 Where a cut has been finished and the slopes dressed in accordance with the plans and slope
4 stakes, the Contractor will not be required to flatten or widen the slopes of a completed cut
5 unless otherwise directed before beginning the work. When rock is unexpectedly
6 encountered, transition any widening or flattening already begun to leave the cut with
7 a pleasing appearance.
- 8 If required, investigate the top 12" of the subgrade in cut sections to determine the necessity
9 for rock undercut.
- 10 Unless otherwise directed, excavate rock in the bottom of roadway cuts to a depth of one foot
11 below the roadbed and ditches. Lower ditches if necessary so that water will drain from the
12 rock surface to the ditches. Upon completion of the rock excavation below the level of the
13 roadbed and ditches, backfill the areas where such rock has been removed with suitable
14 material, compact, and shape to the required grade and cross section.
- 15 Before any work beginning on the structure, excavate all rock under and adjacent to structure
16 sites as directed.
- 17 Bring all cuts to the grade and cross section shown in the plans before final inspection and
18 acceptance.
- 19 Remove and dispose of slides and overbreaks that occur before final acceptance of the project.
20 Where slides and overbreaks occur due to negligence or carelessness on the part of the
21 Contractor, the removal and disposal of said slides and overbreaks will be at no cost to the
22 Department.
- 23 Shape old roadways to produce an acceptable appearance in accordance with Section 808.
- 24 Conduct earthwork operations in a manner that will not disturb staking, utility poles or guy
25 wires required to remain in their original location.
- 26 Cut off and plug all private utility lines, remove existing shoulder drain and subdrain pipe and
27 remove all underground tanks intercepted within the typical section or in conflict with
28 construction.
- 29 Where it is necessary to remove existing sidewalks or driveways, furnish a neat edge along
30 the pavement retained by sawing a neat line approximately 2" deep with a concrete saw
31 before breaking the adjacent pavement away.
- 32 When excavation operations encounter graves, temporarily discontinue operations in the
33 vicinity of the graves and do not resume until directed.
- 34 When excavation operations encounter contaminated soils, temporarily discontinue operations
35 in the vicinity of the contamination and do not resume until directed.
- 36 When excavation operations encounter artifacts of historical or archeological significance,
37 temporarily discontinue operations in the vicinity of the artifacts and do not resume until
38 directed. Disposition of the artifacts shall be in accordance with the requirements of the
39 Division of Archives and History.
- 40 **225-4 UNDERCUT EXCAVATION**
- 41 When the Engineer determines that the natural soil materials in areas where fills are to be
42 placed are undesirable in their location or condition, the Engineer may require the Contractor
43 to remove the undesirable material and backfill with approved, properly compacted material.
- 44 When the Engineer determines that the finished graded roadway cross section contains
45 materials that are undesirable in their location or condition, the Engineer may require the
46 Contractor to remove the materials and backfill with approved, properly compacted material
47 to the finished graded section.

1 Where undercutting is required adjacent to or beneath the location of the proposed drainage
2 structure, perform undercut and backfill a sufficient distance adjacent to the installation to
3 prevent future operations from disturbing the completed drainage structure.

4 Use equipment in undercutting and backfilling operations of such weight, size and capability
5 to efficiently remove and replace the material within the limits established. Use equipment of
6 a size and weight that will not displace the underlying or adjacent material.

7 All material removed in the work of undercut excavation will be classified by the Engineer as
8 either suitable for other use without excessive manipulation and used elsewhere in the work or
9 unsuitable for further use and disposed of by the Contractor.

10 Conduct undercut operations so that the Engineer can take the necessary measurements before
11 any backfill is placed. Place backfill in undercut areas in a continuous operation concurrent
12 with the undercutting operation. Do not place backfill material in water unless otherwise
13 permitted by the Engineer.

14 **225-5 TOLERANCES**

15 A tolerance of ± 0.10 ft from the established grade will be permitted in the roadbed after it has
16 been graded to a uniform surface.

17 **225-6 MAINTENANCE**

18 Maintain all work covered by this section during construction until final acceptance. Provide
19 the drainage of surface runoff along and throughout the length of the cut, construct temporary
20 ditches and use any other methods necessary to control excessive soil erosion during
21 construction and until final acceptance of the project.

22 **225-7 MEASUREMENT AND PAYMENT**

23 *Excavation* will be measured and paid in cubic yards of materials, measured in their original
24 position and computed by the average end area method, acceptably excavated in accordance
25 with the contract. The Engineer may elect to use Digital Terrain Modeling (DTM) for
26 determining the earthwork quantities or other technology that has been proven accurate.
27 Original cross sections for the determination of excavation quantities will be taken before any
28 grading begins. Final cross sections will be taken after the excavation has been completed.
29 Final plan cross sections can be used for the final cross sections where, in the opinion of the
30 Engineer, the work has been constructed in reasonably close conformity to the plan typical
31 section.

32 Original and final cross sections will be taken by either ground or aerial survey methods, as
33 determined by the Engineer.

34 All materials excavated from a location below the graded roadway cross section are classified
35 as *Undercut Excavation* and will be measured separately except for the following:

36 (A) Rock in the bottom of roadway cuts excavated 1 ft or less below the roadbed and ditches;

37 (B) In cut areas, undercut excavation is limited to excavation removed below the roadbed
38 sub-grade, removed below the inside slopes of roadway ditches and removed below the
39 bottom of flat bottom roadway ditches; or

40 (C) Root mat other than grass, removed as a part of clearing and grubbing.

41 When the contract does not include *Drainage Ditch Excavation*, measurement will be made in
42 accordance with Article 240-4 and payment for this class of excavation will be made at the
43 contract unit price per cubic yard for *Unclassified Excavation*.

44 Measurement of materials excavated from overbreaks or slides will be made except where the
45 overbreaks or slides were due to the negligence or carelessness of the Contractor.

Section 226

1 No measurement will be made of any materials excavated outside of authorized excavation
2 limits established by the Engineer or any materials excavated before slope stakes were set.

3 Article 104-5 will not apply for any underruns in the quantity of *Unclassified Excavation*
4 resulting from the permitted use of such material as select granular material.

5 *Berm Ditch Construction* will be measured and paid in accordance with Article 240-4.

6 Materials excavated from stockpiles and used to construct earth shoulders will be paid as
7 *Shoulder Borrow* in accordance with Article 560-4. No payment will be made for the
8 removal and disposal of any surplus material remaining in the stockpile after the shoulders
9 have been completed.

10 Payment for material that the Engineer directs to be removed beyond the limits of the original
11 slope stakes will be made in accordance with Article 104-3.

12 If needed, investigative work within the top 12" of the subgrade to determine the necessity for
13 rock undercut will be paid in accordance with Article 104-7.

14 Payment includes, but is not limited to, excavation, blasting, hauling anywhere along the
15 project both within and across balance points shown in the plans, removal of undesirable
16 material, removal of sidewalk, driveways, curb and gutter, endwalls, traffic islands and
17 drainage structures, disposal of materials, formation and compaction of embankments,
18 subgrades and shoulders, the cutting off, plugging and removal of private utility lines and
19 underground tanks, any backfilling required, removing any existing shoulder drain or subdrain
20 pipe and maintaining the work.

21 Payment for false sumps will be classified as *Unclassified Excavation, Borrow Excavation* or
22 included in *Grading-Lump Sum*. Payment as *Unclassified Excavation* or *Borrow Excavation*
23 will be at the contract unit price per cubic yard.

24 Excavation done in the shaping of old roadways in accordance with Section 808 is paid as
25 *Unclassified Excavation*.

26 Where slides and overbreaks occur due to negligence or carelessness on the part of the
27 Contractor, the removal and disposal of said slides and overbreaks will be incidental to the
28 work of this section.

29 Payment will be made under:

Pay Item	Pay Unit
Unclassified Excavation	Cubic Yard
Undercut Excavation	Cubic Yard

30 **SECTION 226**
31 **COMPREHENSIVE GRADING**

32 **226-1 DESCRIPTION**

33 The work covered by this section consists of all elements of work covered by Sections 200,
34 225, 230, 235, 250, 500 and 560, except that the requirements of the above-referenced
35 sections pertaining to measurement and payment will not apply unless specific reference is
36 made to such.

37 **226-2 CONSTRUCTION METHODS**

38 Perform the work in accordance with Sections 200, 225, 230, 235, 250, 500 and 560.

39 **226-3 MEASUREMENT AND PAYMENT**

40 Seeding and mulching of all borrow sources will be measured and paid at the contract unit
41 prices for such items established in the contract.

1 Payment for material that the Engineer directs the Contractor to obtain from borrow sources
 2 to backfill pipe culverts, box culverts, drainage structures or structure bents will be made in
 3 accordance with Article 104-7.

4 Payment for material that the Engineer directs to be removed beyond the limits of the original
 5 slope stakes will be made in accordance with Article 104-3.

6 *Grading* will be paid at the contract lump sum price. Partial payments will be equal to the
 7 percentage of such item that is complete as estimated by the Engineer. No separate payment
 8 will be made for clearing and grubbing, shoulder and fill slope material or draining borrow
 9 sources as such work will be incidental to the work covered by this section.

10 Clearing and grubbing work that is directed to be performed on areas outside the limits
 11 originally staked or beyond the limits of the right of way or easements shown on the original
 12 plans will be measured and paid at the contract unit price per acre for *Supplementary Clearing
 13 and Grubbing*. All measurements will be made horizontally. Where the contract does not
 14 include this item, a unit price per acre will be established by supplemental agreement.

15 *Undercut Excavation* will be measured and paid at the contract unit price per cubic yard. No
 16 separate payment will be made for materials used in backfilling the undercut areas, shoulders
 17 and slope areas as payment at the contract unit price per cubic yard for *Undercut Excavation*
 18 will be full compensation for furnishing such material. Where the contract does not include
 19 a pay item for *Undercut Excavation*, payment for such excavation will be made in accordance
 20 with Article 104-7.

21 Payment will be made under:

Pay Item	Pay Unit
Grading	Lump Sum
Supplementary Clearing and Grubbing	Acre
Undercut Excavation	Cubic Yard

22 **SECTION 230**
 23 **BORROW EXCAVATION**

24 **230-1 DESCRIPTION**

25 Excavate approved material from borrow sources. Haul and use such material as required in
 26 the plans or as directed. Do not use borrow excavation until all available suitable unclassified
 27 excavation has been incorporated into the embankments, subgrades and shoulders except by
 28 execution of a supplemental agreement documenting the conditions prescribed below.

29 **(A)** All suitable unclassified excavation wasted as a result of the early use of borrow material
 30 will be deducted from the total volume of borrow excavation paid under the contract.

31 **(B)** Reimburse the Department for all additional costs, including additional engineering cost,
 32 associated with the wasting of suitable unclassified excavation.

33 **(C)** Any claim for contract time extensions related to the early use of borrow is waived
 34 should the Contractor use borrow material before all suitable unclassified excavation
 35 being incorporated into the project pursuant to a supplemental agreement.

36 **(D)** The Contractor specifically waives rights to request additional compensation with regard
 37 to the early use of borrow under the compensation requirements of Section 104 except
 38 when unclassified excavation is a major contract item, as defined in Section 101, and that
 39 unclassified excavation overruns by more than 25%.

40 Where the work required to complete the project is so phased by the plans to preclude using
 41 suitable unclassified excavation, the Contractor will be permitted to construct the required
 42 embankments, subgrades or shoulders so controlled by the phasing from approved borrow
 43 materials without having to execute the above required supplemental agreement.

Section 230

1 **230-2 COORDINATION WITH SEEDING OPERATIONS**

2 Coordinate the work in this section with the construction of embankments in accordance with
3 Article 225-2.

4 **230-3 MATERIALS**

5 Refer to Division 10.

Item	Section
Borrow Material	1018
Shoulder and Slope Material	1019

6 **230-4 CONSTRUCTION METHODS**

7 **(A) General**

8 Thoroughly clear and grub and clean the surface of the borrow area of all unsuitable
9 material before beginning the excavation and, where applicable, before cross sections are
10 taken. Dispose of material resulting from clearing and grubbing in accordance with
11 Article 200-6. Remove and dispose of overburden in accordance with Section 802.

12 Do not accumulate exposed, erodible slope area in each borrow operation in excess of
13 1 acre at any one time without beginning permanent seeding and mulching of the borrow
14 source or installing other erosion control measures as may be approved.

15 Remove and stockpile topsoil at locations that will not interfere with the borrow
16 operations and that meet the approval of the Engineer. Install temporary erosion control
17 measures as needed to prevent the erosion of the stockpile material. Once all borrow has
18 been removed from the source or portion thereof, uniformly spread the stockpiled topsoil
19 over the area and permanently seed and mulch the area.

20 Where payment is made by cross section, notify the Engineer sufficiently before
21 beginning excavation of the borrow material so that the area may be staked and
22 cross sectioned. Excavate the material to the lines and slopes as staked in an orderly
23 manner to facilitate measurement at any time.

24 Where payment is to be made by truck measurement, furnish trucks with bodies suitable
25 for accurate measurement. Load trucks uniformly and to prevent spillage.

26 When necessary to haul borrow material over existing roads or streets, comply with
27 Article 105-15. Use all necessary precautions to prevent damage to the existing
28 structures or pavement. Conduct hauling operations so as to not interfere with the normal
29 flow of traffic and keep the traffic lanes free from spillage at all times.

30 Furnish borrow sources except where otherwise indicated in the contract.

31 **(B) Contractor Furnished Sources**

32 Before the approval of any borrow sources developed for use on any project, obtain
33 certification from the State Historic Preservation Officer of the State Department of
34 Cultural Resources certifying that the removal of the borrow material from the borrow
35 sources will have no effect on any known district, site building, structure or object,
36 architectural and/or archaeological that is included or eligible for inclusion in the
37 National Register of Historic Places. Furnish a copy of this certification to the Engineer
38 before performing any work on the proposed borrow source.

39 Borrow sources will not be allowed in any area under the Corps of Engineers regulatory
40 jurisdiction until the Contractor has obtained a permit for such borrow sources from the
41 Corps District Engineer having jurisdiction and has furnished a copy of this permit to the
42 Engineer. Requests for additional contract time, additional compensation or for work
43 stoppage due to permit violations will not be considered.

1 The approval of borrow sources furnished by the Contractor is subject to the following
2 conditions:

3 (1) Proof of Rights

4 Provide written proof of the right to take the material and any rights of access that
5 may be necessary, for locating and developing the source and any clearing and
6 grubbing and drainage ditches necessary. The proof shall include an agreement with
7 the owner that the borrow source be dressed, shaped, seeded, mulched and drained as
8 required by these Specifications after all borrow has been removed.

9 (2) Sampling and Testing

10 Sampling and testing of contractor furnished borrow material will be in accordance
11 with procedures set forth in the *Borrow Pit Sampling Manual* in effect on the date of
12 advertisement for the project. Copies of this document are available from the
13 Materials and Tests Unit. The criteria for acceptance of the proposed contractor
14 furnished borrow material is shown in Section 1018.

15 (3) Reclamation Plan

16 Except where borrow is to be obtained from a commercial source, jointly submit
17 with the property owner a borrow source development, use and reclamation plan to
18 the Engineer for his approval before engaging in any land disturbing activity on the
19 proposed source other than material sampling that may be necessary. The
20 Department's borrow and waste site reclamation procedures for contracted projects
21 is available on the website and shall be used for all borrow and waste sites on this
22 project. Address the following in the plan:

23 (a) Topography

24 Detail the existing topography and locations of the proposed access and egress
25 haul roads. Detail the proposed final topography of the waste or disposal area
26 showing any proposed drainage systems. Excavate the source according to the
27 plan and dress and shape it in a continuous manner to contours that are
28 comparable to and blend in with the adjacent topography. Grade the source to
29 drain such that no water will collect or stand. Provide a functioning drainage
30 system for the source. If drainage is not practical and the source is to serve as
31 a pond, the minimum depth shall be a least 4 ft as determined from the water
32 table at the time the reclamation plan is executed. The slope of the soil below
33 the water shall be between 5:1 and 2:1. The slope of the sides above the water
34 line shall be 2:1 or flatter.

35 (b) Erosion Control

36 Detail the temporary and permanent erosion control measures, along with design
37 calculations, that are intended during use of the site and as part of the
38 reclamation. Unless considered impractical due to special circumstances,
39 provide in the plan for the use of staged permanent seeding and mulching and
40 appropriate fertilizer topdressing continually during site use and the immediate
41 total reclamation of the site when the site is no longer needed. Define the seed
42 mixture proposed for establishing temporary and permanent vegetation.
43 Establish permanent stand of vegetation before acceptance of the project.

Section 230

(4) Buffer Zones

Allocate sufficient area between the nearest property line and the tie-in of the slope to natural ground to allow for the operation of excavation, hauling and seeding equipment and for the installation of any and all erosion control devices required. Leave additional undisturbed area between the source and any water course or body to prevent siltation of the water course or body and the movement of the shore line either into the water course or body or into the waste areas. Determine if the adjoining property owners or other government agencies require any additional buffer zones and comply with those requirements. Suggested minimum distances are 10 ft from property lines and 50 ft from water bodies or water courses. Where it is necessary to drain the borrow source, perform work in accordance with Section 240.

(5) Evaluation for Potential Wetlands and Endangered Species

Hire an experienced environmental consultant from the approved list to perform an assessment of the borrow site for potential conflicts with wetlands, Areas of Environmental Concern designated by the Coastal Area Management Act and federally protected species. This evaluation will not be required for permitted commercial sites.

Delineate the boundaries of any wetlands, jurisdictional surface waters and streams encountered. Follow the standard practice for documenting the wetland delineation including completion of the Army Corps of Engineers' Approved Jurisdictional Determination Form. Document information including data regarding soil, vegetation and hydrology. Maintain a minimum 25 ft buffer adjacent to all sides of the wetland boundary and a minimum 50 ft buffer adjacent to any stream. Depict the limits of the delineated wetland and surrounding buffer on the Reclamation Plan. Do not remove borrow material in any area under the Corps of Engineers' or any other environmental agencies' regulatory jurisdiction unless and until the Department permit has been modified to allow such disposal activity in the jurisdictional area.

Perform a site assessment for federally listed threatened or endangered species to include habitats that may support these species. Provide a detailed technical report on the assessment findings. If federally listed threatened or endangered species or habitat that may support such species exist on the proposed borrow site, notify the Engineer before continued pursuit of such site.

(6) Approval

Obtain written approval from the Engineer before excavating any material within the proposed borrow source area.

Submit a revised or additional reclamation plan if the non-permitted waste or disposal area is expanded by more than one acre or is significantly changed from the previously approved submittal.

If the Contractor proposes a borrow source, the environmental assessment shall include wetland and stream delineation extending 400 ft beyond the proposed borrow source limits.

(a) If wetlands or streams are present within 400 ft of the borrow source, submit a hydrologic analysis (Skaggs Method) or equivalent to determine if lateral effects will permanently impact or cause degradation to wetlands or streams. Perform analysis with an environmental or hydraulics engineer with expertise in this discipline and include:

- (i) Hydric soil type,
- (ii) Average profile depth to restrictive soil layer,
- (iii) Effective hydraulic conductivity or permeability,
- (iv) Average drainable porosity or available water capacity and
- (v) Required buffer width, including safety factor.

1 (b) If wetlands or streams are present within 400 ft and the Contractor does not
 2 propose to excavate below the seasonal high water table or the water level in the
 3 adjacent stream, no documentation will be required.

4 (c) If wetlands or streams are not present within 400 ft, no additional documentation
 5 will be required.

6 During Department review of the proposed borrow area, the hydrologic analysis will
 7 be submitted to the U.S. Army Corps of Engineers for evaluation. Obtain copy of
 8 *Skaggs Method for Determining Lateral Effects of a Borrow Pit on Adjacent*
 9 *Wetlands* from the Department's website.

10 (C) Maintenance

11 During construction and until final acceptance, use any methods approved by the
 12 Engineer that are necessary to maintain the work covered by this section so that the work
 13 will not contribute to excessive soil erosion.

14 230-5 MEASUREMENT AND PAYMENT

15 *Borrow Excavation* will be measured and paid in cubic yards. Borrow excavation will be
 16 measured in place in its original position except that truck measurement will be made where
 17 called for in the contract.

18 If the quantity of borrow excavation used is excessive as evidenced by the presence of surplus
 19 suitable material from the roadway excavation, the measured quantity of borrow excavation
 20 will be reduced by the quantity of such surplus suitable material.

21 (A) In-Place Measurement

22 *Borrow Excavation* to be paid will be the actual number of cubic yards of approved
 23 material, measured in its original position by cross sectioning and computed by the
 24 average end area method, that has been excavated from the borrow source and
 25 incorporated into the completed and accepted work. No measurement will be made of
 26 any overburden, unsuitable material removed from the source or any material excavated
 27 before cross sections are taken.

28 (B) Truck Measurement

29 *Borrow Excavation* to be paid will be the actual number of cubic yards of approved
 30 material, measured in trucks excavated from the borrow source and incorporated into the
 31 completed and accepted work. Each truck will be measured and shall have a legible
 32 identification mark indicating its capacity. Load each truck to at least its measured
 33 capacity at the time it arrives at the point of delivery. The recorded capacity will be
 34 adjusted by making a 25% deduction to allow for shrinkage and the adjusted capacity will
 35 be the quantity to be paid.

36 Topsoil that is stockpiled and placed back on the source as part of the reclamation effort will
 37 be measured in the stockpile by cross sectioning and computed by the average end area
 38 method and paid per cubic yard for *Borrow Excavation*. No in-place measurement will be
 39 made of the topsoil.

40 Seeding, mulching and establishment of temporary erosion control for all borrow sources will
 41 be paid at the contract unit prices for the items established in the contract as payment for
 42 *Seeding And Mulching* in Section 1660.

Section 235

1 Payment includes, but is not limited to, furnishing the source of the borrow; providing and
2 implementing a development, use and reclamation plan, evaluation of potential wetlands and
3 endangered species, building, maintaining and obliterating haul roads, clearing and grubbing
4 or draining the borrow source; removing, stockpiling and replacing topsoil, removing and
5 disposing of overburden and other unsuitable material, excavation, hauling, formation of
6 roadway embankments, subgrades and shoulders, restoration of the source and haul roads to
7 an acceptable condition, obtaining permits and certifications and maintaining the work.

8 Payment will be made under:

Pay Item	Pay Unit
Borrow Excavation	Cubic Yard

9 **SECTION 235**
10 **EMBANKMENTS**

11 **235-1 DESCRIPTION**

12 Place suitable material excavated under Sections 225, 226, 230 and 240 in embankments,
13 backfills and earth berms, to conform with the lines, grades and typical cross sections shown
14 in the plans. Fill and compact holes, pits and other depressions when unsuitable material has
15 been removed. Work includes preparation, formation, compaction and maintenance of the
16 embankment area as well as the formation of benches in the existing ground with rises less
17 than 60".

18 **235-2 MATERIALS**

19 Refer to Division 10.

20 Use soil consisting of loose, friable, sandy material free of subsoil admixtures, refuse, stumps,
21 rocks, roots, root mats or other unsatisfactory material. Do not use material that meets
22 AASHTO M 145 for soil classification A-2-5 and A-5 with a PI of less than 8 within 12" of
23 the subgrade.

24 Wet, dry or frozen material may be suitable when dried, wetted or thawed, respectively.
25 Aerate and dry material containing moisture content in excess of what is required to achieve
26 embankment stability and specified density. Waste suitable material only with written
27 authorization.

28 **235-3 CONSTRUCTION METHODS**

29 Coordinate work with excavation operations in accordance with Articles 107-12 and 225-2.

30 **(A) Preparation for Embankment**

31 Finish clearing and grubbing within an area before starting embankment in accordance
32 with Section 200. Remove and waste organic or other unsuitable material unless
33 otherwise directed.

34 Plow mowed sod and leave in place where the height of embankment to be constructed is
35 greater than 6 ft measured under the roadbed. Plow or scarify and break up cleavage
36 planes of all underlying road surfaces. Remove or break up existing pavement in
37 accordance with Section 250.

38 Bench existing slopes steeper than 4:1 measured at right angles to the roadway. Provide
39 rises of at least 12" and no more than 60" as embankment is brought up in layers.
40 Provide sufficient width for the operation of placing and compaction equipment. Begin
41 bench cut at the intersection of the original ground and the vertical side of the previous
42 cut. Construct benches greater than 60" in height only when shown in the plans. Such
43 benches will be paid in accordance with the contract.

(B) Embankment Formation

1
2 Uniformly spread material in successive, approximately horizontal layers of not more
3 than 10" depth, loose measurement, for the full width of the cross section. Compact each
4 layer in accordance with Subarticle 235-3(C).

5 Shape embankment surface to properly drain at all times.

6 Route construction equipment uniformly over the full width of the embankment and
7 prevent deep rutting.

8 May construct the first layer of embankments across saturated or unstable material, that
9 does not support the weight of hauling equipment, by successively dumping a uniformly
10 distributed layer of a thickness not greater than necessary to support hauling equipment
11 while placing subsequent layers.

12 When placing material in swamp or in water, keep unsuitable surge material in a fluid
13 state or remove to prevent trapping in or under embankment.

14 When shown in the plans or allowed by the contract, form a satisfactory base by end or
15 side dumping in valleys, ravines and at the foot of slopes on side hills.

16 Where embankments are being constructed principally of rock or broken pavement, place
17 in uniform layers with a maximum depth of 36". Place rock or broken pavement so
18 larger pieces are evenly distributed and are no larger than 36" in any dimension. Fill all
19 voids. Place rock or broken pavement lifts at least 2 ft below finished subgrade or
20 finished grade whichever is lower.

21 Do not place rock or broken pavement greater than 2" in diameter within 12" of the
22 subgrade or finished grade whichever is lower. Do not place rock or broken pavement in
23 areas where foundations are to be placed.

24 Place select material where indicated in the contract. Construct the top 6" of shoulder
25 and fill slopes with material that meets Article 1019-2. Construct stabilized embankment
26 when required by the contract.

27 Install pipe culverts as specified in Section 300. Construct subsurface drains adjacent to
28 structures as required by Article 414-8 for box culverts, except for that portion of the
29 drain located below the elevation of the original ground. Do not disturb existing utilities
30 within the project construction limits until released by the Engineer.

31 Do not place rock or broken pavement in embankment areas where piles or drilled shaft
32 foundations are to be constructed or where underground utilities exist. This requirement
33 shall include, but not be limited to, piles and foundations for structures, metal signal
34 poles, overhead sign structures and high mount lighting.

(C) Embankment Compaction

35
36 Compact each layer for its full width to a density equal to at least 95% of that obtained by
37 compacting a sample of the material in accordance AASHTO T 99 as modified by the
38 Department. Copies of these modified procedures are available upon request from the
39 Department's Materials and Tests Unit.

40 Uniformly bond all layers to preceding layers. Compact all surfaces on embankment
41 slopes, principally constructed of soil, that are flatter than 1.5:1 using tracked equipment
42 or other approved methods.

43 Increase or decrease moisture content of the material before compacting to produce the
44 maximum density that will provide a stable grade. Exempt portions of rock
45 embankments, that cannot be tested by approved methods, from density requirements.

Section 240

1 (D) Maintenance

2 Maintain all embankments made under the contract until final acceptance. Construct and
3 maintain adequate drainage of surface runoff to prevent soil erosion. Replace damaged
4 or displaced embankment.

5 Bring all embankments to the grade and cross section shown in the plans before final
6 inspection and acceptance.

7 235-4 TOLERANCES

8 Finish subgrade surface within ± 0.10 ft from the established grade after it has been graded to
9 a uniform surface.

10 235-5 MEASUREMENT AND PAYMENT

11 Payment will not be made for embankment construction. Payment at the contract unit prices
12 for the various items covered by Sections 225, 226, 230 and 240 will be full compensation for
13 all work covered by this section.

14 Repairs to embankments caused by Contractor carelessness or negligence will be incidental to
15 the work of Sections 225, 226, 230 and 240. Repairs to embankments as a result of natural
16 causes will be at the contract unit price for the excavated material required to make the
17 necessary repairs.

18 SECTION 240 19 DITCH EXCAVATION

20 240-1 DESCRIPTION

21 Excavate and satisfactorily dispose of all materials excavated in the construction of ditches
22 except silt ditches.

23 (A) Drainage Ditches

24 Define "drainage ditches" as inlet and outlet ditches for pipe culverts and structures,
25 changes in channels of streams, ditches draining borrow and material sources and parallel
26 or lateral ditches when such ditches are separated from the roadway slope by an area of
27 natural ground or berm.

28 Unless otherwise classified in the plans, parallel or lateral ditches constructed as
29 an integral part of the graded roadbed, having a continuous slope from the outer limit of
30 the shoulder to the bottom of the ditch, will be considered to be within the roadway
31 grading limits and will be part of the work covered by Section 225.

32 (B) Berm Ditches

33 Define "berm ditches" as ditches constructed by either excavation or the construction of
34 earth berms along the top of cut slopes. The location of berm ditches will be as shown in
35 the plans or as directed.

36 240-2 GENERAL

37 Excavate to the lines, grades, typical sections and details shown in the plans or established.
38 Coordinate all work covered by this section with the grading, construction of drainage
39 structures, excavation of borrow and material sources and other work along the project and
40 maintain in a satisfactory condition so that adequate drainage is provided at all times.
41 Maintain the ditches until the final acceptance of the project. Trim flush with the sides of the
42 ditch any roots that protrude into the ditch. Complete inlet and outlet ditches for pipelines
43 before the pipe is installed unless otherwise permitted.

Section 260

1 Where the Contractor requests permission to use salvageable material in other parts of the
2 work and such material has been intended for use in the construction of embankments, the
3 Engineer may permit such use provided the Contractor furnishes at no cost to the Department
4 an adequate quantity of material for embankment construction to replace the material used in
5 all other parts of the work.

6 Dispose of all materials that cannot be used in the work in accordance with Section 802.

7 **250-3 MEASUREMENT AND PAYMENT**

8 *Removal of Existing Asphalt Pavement* will be measured and paid in square yards of existing
9 asphalt pavement actually removed and disposed of properly. Removal of existing asphalt
10 pavement will be measured by actual surface measurement of the asphalt pavement before its
11 removal.

12 *Removal of Existing Concrete Pavement* will be measured and paid in square yards of existing
13 concrete pavement actually removed and disposed of properly. Removal of existing concrete
14 pavement will be measured by actual surface measurement of the concrete pavement before
15 its removal.

16 *Breaking of Existing Concrete Pavement* will be measured and paid in square yards of
17 existing concrete pavement actually broken up and left in place. The quantity will be
18 determined by actual surface measurement of the pavement before breaking it up.

19 *Breaking of Existing Asphalt Pavement* will be measured and paid in square yards of existing
20 asphalt pavement actually broken up and left in place. The quantity will be determined by
21 actual surface measurement of the pavement before breaking it up.

22 Where the pavement removed or broken up is a combination of layers of both asphalt and
23 concrete pavement, payment will be made at the contract unit price per square yard for
24 *Removal of Existing Concrete Pavement* or *Breaking of Existing Concrete Pavement*.

25 Where the pavement removed is a combination of layers of both asphalt and concrete
26 pavement and an item is not established for concrete pavement removal, the cost of removing
27 the combination of layers of asphalt and concrete will be made in accordance with
28 Article 104-7.

29 Payment includes, but is not limited to, breaking up, removing and disposing of existing
30 concrete or asphalt pavement, including paved shoulders and removing any temporary
31 roadway pavement structure placed during construction to serve as a detour.

32 This work does not include pavement removal for pipe installation; removing and disposing
33 of sidewalks, driveways, curb and gutter; traffic islands and parking areas; or any other
34 incidental paved structures that are not part of a roadway pavement structure.

35 Payment will be made under:

Pay Item	Pay Unit
Removal of Existing Asphalt Pavement	Square Yard
Removal of Existing Concrete Pavement	Square Yard
Breaking of Existing Concrete Pavement	Square Yard
Breaking of Existing Asphalt Pavement	Square Yard

36

SECTION 260 PROOF ROLLING

37

38 **260-1 DESCRIPTION**

39 Furnish and operate at the direction of the Engineer, heavy pneumatic tired compaction
40 equipment for compacting the roadbed and testing the roadbed for stability and uniformity of
41 compaction.

1 260-2 EQUIPMENT

2 Provide equipment with the following features:

- 3 (A) Four rubber tired wheels mounted on a rigid steel frame,
- 4 (B) Wheels evenly spaced in one line across the width of the roller and arranged so that all
5 wheels will carry approximately equal loads when operated over an uneven surface,
- 6 (C) Maximum center to center spacing between adjacent wheels is 32",
- 7 (D) Load capacity from 48 to 50 tons unless otherwise permitted in writing,
- 8 (E) Cover or construct the loaded roller to not trap water that will add weight to the ballast,
- 9 (F) Other equipment of equal or better effectiveness may be substituted with written
10 permission, and
- 11 (G) Tire pressures shall be between 68 and 72 psi unless otherwise permitted in writing.
12 Inflate tires with air only; use no liquid.

13 Provide ballasts consisting of bulk sand, bulk stone, bags of sand, stone or other materials of
14 known unit weight such that the total weight of the ballast used can be readily determined at
15 all times. Provide a sufficient amount of ballast to load the equipment to a maximum gross
16 weight of 50 tons.

17 Use rubber tired or other types of tractive equipment for operation of this equipment on the
18 roadbed. The entire assembly including motivating equipment shall be capable of executing
19 a 180° turn on a 27 ft wide area.

20 260-3 CONSTRUCTION METHODS

21 After the roadbed has been completed within 0.5 ft of final grade, compact and test the
22 roadbed with one coverage, unless otherwise directed, with a heavy pneumatic tired roller in
23 accordance with Article 260-2. Coverage is considered that stage in the rolling procedure
24 when the entire width of the area being proof rolled has been in contact with the pneumatic
25 tires of the roller. Operate the roller systematically so the number of coverages over all areas
26 to be proof rolled can be readily determined and recorded.

27 Operate the equipment at a speed between 225 ft/min and 300 ft/min. Perform proof rolling
28 only in the presence of the Engineer. Proof roll areas again following the completion of the
29 necessary corrections.

30 Protect all structural facilities on the project, such as, but not limited to, bridges, box culverts,
31 pipe culverts and utilities, from damage by the proof rolling equipment. Protection may
32 include unloading and reloading of the roller, detouring, protective earth pads or other suitable
33 measure to avoid damage.

34 260-4 MEASUREMENT AND PAYMENT

35 *Proof Rolling* will be measured and paid as the actual number of hours, measured to the
36 nearest 0.1 hour, during which the heavy pneumatic tired roller has been engaged in proof
37 rolling in the presence of the Engineer, exclusive of hours of proof rolling performed
38 following corrective action made necessary by the negligence of the Contractor or by weather.

39 Corrective work necessary, as determined by proof rolling, and not due to negligence of the
40 Contractor or to weather, will be paid at the applicable contract unit prices or as extra work,
41 whichever may apply.

42 Proof rolling after corrective work will be at no cost to the Department if the corrections are
43 necessary due to the negligence of the Contractor or weather.

44 Payment includes furnishing all labor, equipment, fuel and ballast for loading, loading and
45 unloading ballast as directed and increasing and decreasing tire pressure as directed.

Section 265

1 Payment will be made under:

Pay Item	Pay Unit
Proof Rolling	Hour

2 **SECTION 265**
3 **SELECT GRANULAR MATERIAL**

4 **265-1 DESCRIPTION**

5 Furnish and place select granular material in accordance with the contract and as directed.

6 **265-2 MATERIALS**

7 Refer to Division 10.

Item	Section
Select Material, Class II	1016
Select Material, Class III	1016

8 **265-3 CONSTRUCTION METHODS**

9 Use only Class III select material for embankments in water.

10 Place select granular material up to 3 ft above geotextile for soil stabilization and the water
11 level.

12 **265-4 MEASUREMENT AND PAYMENT**

13 Select granular material will be paid as *Select Granular Material* unless the material is
14 obtained from the same source as the borrow material and the contract includes a pay item for
15 *Borrow Excavation*. When this occurs, *Select Granular Material* will be paid at the lower bid
16 price per cubic yard for either *Borrow Excavation* or *Select Granular Material*.

17 *Select Granular Material* will be measured and paid in cubic yards. When undercut
18 excavation is in accordance with Section 226 and the Engineer requires undercut to be
19 backfilled with select granular material, the second sentence of the sixth paragraph of
20 Article 226-3 will not apply, as payment for the backfill will be made as described in this
21 article.

22 *Select Granular Material* will be measured by in place measurement in accordance with
23 Article 230-5 or by weighing material in trucks in accordance with Article 106-7 as
24 determined by the Engineer. When select granular material is weighed in trucks, a unit
25 weight of 135 lb/cf will be used to convert the weight of select granular material to cubic
26 yards. At the Engineer's discretion, truck measurement in accordance with Article 230-5 may
27 be used instead of weighing material in trucks.

28 The contract unit prices for *Select Granular Material* and *Borrow Excavation* as described
29 above will be full compensation for providing, transporting, handling, placing, compacting
30 and maintaining select granular material.

31 Payment will be made under:

Pay Item	Pay Unit
Select Granular Material	Cubic Yard

32 **SECTION 270**
33 **GEOTEXTILE FOR SOIL STABILIZATION**

34 **270-1 DESCRIPTION**

35 Furnish and place geotextile for soil stabilization in accordance with the contract and as
36 directed.

1 **270-2 MATERIALS**

2 Refer to Division 10.

Item

Geotextile for Soil Stabilization, Type 4

Section

1056

3 **270-3 CONSTRUCTION METHODS**

4 Grubbing may not be required in areas where geotextile for soil stabilization will be used.
5 Minimize the use of heavy equipment in these areas to limit rutting. Cut trees flush with the
6 ground surface and place geotextiles on relatively undisturbed ground as directed.

7 Do not leave geotextiles exposed for more than 7 days before covering geotextiles with
8 backfill material except geotextiles for erosion control devices. Place geotextiles on surfaces
9 free of obstructions, debris and soft pockets. Install geotextiles with the long dimension
10 parallel to the roadway centerline. Overlap adjacent geotextiles at least 18" unless otherwise
11 directed to sew seams together. Overlap geotextiles in the direction that material will be
12 placed to prevent lifting the edge of the top geotextile.

13 Place geotextiles in slight tension free of kinks, folds, wrinkles or creases. Use wire staples or
14 anchor pins, as needed, to hold geotextiles in place until covered. Provide backfill material in
15 accordance with the contract. Do not operate equipment on geotextiles until covered with
16 material as directed. Do not use vibratory compaction equipment on initial lifts of backfill.

17 **270-4 MEASUREMENT AND PAYMENT**

18 *Geotextile for Soil Stabilization* will be measured and paid in square yards. Geotextiles will
19 be measured along the ground surface as the square yards of exposed geotextiles before
20 placing backfill material. No measurement will be made for overlapping geotextiles or
21 sewing seams. The contract unit price for *Geotextile for Soil Stabilization* will be full
22 compensation for providing, transporting and placing geotextiles, wire staples and anchor pins
23 and sewing geotextiles.

24 Payment will be made under:

Pay Item

Geotextile for Soil Stabilization

Pay Unit

Square Yard

25

SECTION 275 ROCK PLATING

26

27 **275-1 DESCRIPTION**

28 Construct rock plating in accordance with the contract. Rock plating is required to stabilize
29 slopes at locations shown in the plans and as directed.

30 **275-2 MATERIALS**

31 Refer to Division 10.

Item

Geotextile for Rock Plating, Type 2

Plain Rip Rap

Select Material, Class IV

Subsurface Drainage Materials

Section

1056

1042

1016

1044

32 Use Class IV select material (standard size No. ABC) over rip rap and Class 1, 2 or B rip rap
33 unless required otherwise in the plans. Provide Type 2 geotextiles for filtration geotextiles.
34 Provide subdrain coarse aggregate (standard size No. 78M) and PVC subdrain pipes, fittings
35 and outlet pipes for subsurface drainage materials.

Section 275

1 **275-3 CONSTRUCTION METHODS**

2 Construct embankments in accordance with the contract. Compact fill slopes to the
3 satisfaction of the Engineer with tracked equipment or other approved methods. Undercut as
4 necessary to install rock plating on cut slope faces or embed rock plating below the ground
5 line.

6 Do not leave filtration geotextiles exposed for more than 7 days before covering with rip rap
7 or ABC. Unroll geotextiles down slopes, i.e., perpendicular to the roadway centerline. Bury
8 filtration geotextiles at top of slopes and embed geotextiles at toe of slopes as shown in the
9 plans. Filtration geotextiles should be continuous down slopes. If geotextile roll length is too
10 short, overlap ends of geotextile rolls at least 5 ft with the upper geotextile over the lower as
11 shown in the plans. Filtration geotextiles may be discontinuous down slopes in the direction
12 perpendicular to the roadway centerline only once per roll width.

13 Overlap adjacent filtration geotextiles along slopes at least 18" as shown in the plans. Place
14 geotextiles in slight tension free of kinks, folds, wrinkles or creases. Use wire staples or
15 anchor pins as needed to hold filtration geotextiles in place until covered. Do not displace or
16 damage filtration geotextiles while placing rip rap. When shown in the plans, install
17 6" diameter perforated subdrain pipes and No. 78M stone at toe of slopes in accordance with
18 Article 815-3.

19 Place rip rap such that the smaller stones are uniformly distributed throughout rip rap. Install
20 rip rap with mechanical methods and if necessary, by hand to form a well graded, dense, neat
21 layer of rip rap.

22 When shown in the plans, place filtration geotextiles and 18" of ABC over rip rap at top of
23 slopes. Compact ABC to 92% of AASHTO T 180 as modified by the Department or to the
24 highest density that can be reasonably obtained.

25 **275-4 MEASUREMENT AND PAYMENT**

26 *Rock Plating* will be measured and paid in square yards. Rock plating will be measured along
27 the slope faces of rock plated slopes as the square yards of exposed rip rap and if applicable,
28 ABC. No measurement will be made for portions of rock plating embedded below the ground
29 line. The contract unit price for *Rock Plating* will be full compensation for providing,
30 transporting and placing filtration geotextiles, wire staples, anchor pins, rip rap and ABC.
31 The contract unit price for *Rock Plating* will be full compensation for undercut excavation to
32 install rock plating on cut slope faces and embed rock plating below the ground line.

33 *Subsurface Drainage* will be measured and paid in accordance with Section 815.

34 Payment will be made under:

Pay Item	Pay Unit
Rock Plating	Square Yard

DIVISION 3 PIPE CULVERTS

SECTION 300 PIPE INSTALLATION

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300-1 GENERAL

Excavate, undercut, provide material, condition foundation, lay pipe, joint and couple pipe sections and furnish and place all backfill material as necessary to install the various types of pipe culverts and fittings required to complete the project.

Install pipe in accordance with the details in the plans.

Do not waste excavation unless permitted. Use suitable excavated material as backfill; or in the formation of embankments, subgrades and shoulders; or as otherwise directed. Furnish disposal areas for the unsuitable material. The Engineer will identify excavated materials that are unsuitable.

Where traffic is to be maintained, install pipe in sections so half the roadway width is available to traffic.

300-2 MATERIALS

Refer to Division 10.

Item	Section
Flowable Fill	1000-6
Geotextiles	1056
Joint Materials	1032-9(F)
Select Materials	1016

Provide foundation conditioning material in accordance with Article 1016-3 for Class V or VI select material as shown in the contract.

Provide bedding material in accordance with Article 1016-3 for Class II (Type 1 only) or Class III select material as shown in contract.

Provide backfill material in accordance with Article 1016-3 for Class II (Type 1 for flexible pipe) or Class III select material as shown in the contract.

Provide filtration geotextile in accordance with Section 1056 for any type of geotextile.

Provide foundation conditioning geotextile in accordance with Article 1056-2 for Type 2 geotextile.

Do not use corrugated steel pipe in counties listed in Article 310-2.

300-3 UNLOADING AND HANDLING

Unload and handle pipe with reasonable care. Do not roll or drag metal pipe or plates over gravel or rock during handling. Take necessary precautions to ensure the method used in lifting or placing the pipe does not induce stress fatigue in the pipe. Use a lifting device that uniformly distributes the weight of the pipe along its axis or circumference. Repair minor damage to pipe when permitted. Remove pipe from the project that is severely damaged or is rejected as being unfit for use. Undamaged portions of a joint or section may be used where partial lengths are required.

Section 300

1 300-4 PREPARATION OF PIPE FOUNDATION

2 Prepare the pipe foundation in accordance with the applicable method as shown in the
3 contract documents, true to line and grade and uniformly firm.

4 Where material is found to be of poor supporting value or of rock and when the Engineer
5 cannot make adjustment in the location of the pipe, undercut existing foundation material
6 within the limits established in the plans. Backfill the undercut with foundation conditioning
7 material. Encapsulate the foundation conditioning material with foundation conditioning
8 geotextile before placing bedding material. Overlap all transverse and longitudinal joints in
9 the geotextile at least 18".

10 Maintain the pipe foundation in a dry condition.

11 300-5 INVERT ELEVATIONS

12 The proposed pipe culvert invert elevations shown on the Drainage Summary Sheets are
13 based upon information available when the plans were prepared. If proposed invert elevations
14 are adjusted during construction based upon actual conditions encountered, no claim for an
15 extension of time for any reason resulting from this information will be allowed.

16 When a pipe culvert is to be installed in a trench and the average actual elevation of the pipe
17 between drainage structures deviates from the average proposed elevation shown on the
18 Drainage Summary Sheets by more than one foot, a pay adjustment will be made as follows:

$$\text{Pay Adjustment (per linear foot)} = [(APE - AAE) \pm 1](0.15 \times CUP)$$

Where:

$$APE = \text{Average Plan Elev.} = \frac{(\text{Plan Inlet Elev.} + \text{Plan Outlet Elev.})}{2}$$

$$AAE = \text{Average Actual Elev.} = \frac{(\text{Actual Inlet Elev.} + \text{Actual Outlet Elev.})}{2}$$

$$CUP = \text{Contract Unit Price of Pipe Culvert}$$

19 When the actual location of a pipe culvert is changed from the location shown in the plans,
20 the Engineer will make a pay adjustment deemed warranted based upon the relation of the
21 pipe culvert as shown in the plans to the finished roadway and the relation of the pipe culvert
22 as constructed to the finished roadway.

23 The top elevation column on the drainage summary sheet indicates the flow elevation at the
24 top of structures intended to collect surface water.

25 The top elevation column on drainage structures not intended to collect surface water
26 indicates the elevation at the top of the cover.

27 300-6 LAYING PIPE

28 The Department reserves the right to perform forensic testing on any installed pipe.

29 (A) Rigid Pipe

30 Concrete and welded steel pipe will be considered rigid pipe. Lay pipe on prepared
31 foundation, bell or groove end upgrade with the spigot or tongue fully inserted. Check
32 each joint for alignment and grade as the work proceeds.

33 Use flexible plastic joint material except when material of another type is specified in the
34 contract documents. Joint material of another type may be used when permitted.

1 Repair lift holes in concrete pipe, if present. Thoroughly clean and soak the lift hole and
2 completely fill the void with an approved non-shrink grout. Submit alternate details for
3 repairing lift holes to the Engineer for review and approval.

4 For all pipes 42" in diameter and larger, wrap filtration geotextile around all pipe joints.
5 Extend geotextile at least 12" beyond each side of the joint. Secure geotextile against the
6 outside of the pipe by methods approved by the Engineer.

7 **(B) Flexible Pipe**

8 Corrugated steel, corrugated aluminum, corrugated HDPE and PVC pipe will be
9 considered flexible pipe. Place flexible pipe carefully on the prepared foundation starting
10 at the downstream end with the inside circumferential laps pointing downstream and with
11 the longitudinal laps at the side or quarter points.

12 Handle coated corrugated steel pipe with special care to avoid damage to coatings.

13 Join pipe sections with coupling band, fully bolted and properly sealed. Provide coupling
14 bands for annular and helical corrugated metal pipe with circumferential and longitudinal
15 strength sufficient to preserve the alignment, prevent separation of the sections and
16 prevent backfill infiltration. Match-mark all pipe 60" or larger in diameter at the plant for
17 proper installation on the project.

18 At locations indicated in the plans, join corrugated steel pipe sections together with rod
19 and lug coupling bands, fully bolted. Use sleeve gaskets in conjunction with rod and lug
20 couplings and seal the joints properly. Provide coupling bands with circumferential and
21 longitudinal strength sufficient to preserve the alignment, prevent separation of the
22 sections and prevent infiltration of backfill material.

23 **300-7 BACKFILLING**

24 Loosely place bedding material, in a uniform layer, a depth equal to the inside diameter of the
25 pipe divided by 6 or 6", whichever is greater. Leave bedding material directly beneath the
26 pipe uncompacted and allow pipe seating and backfill to accomplish compaction. Excavate
27 recesses to receive the bells where bells and spigot type pipe is used.

28 Place fill around the pipe in accordance with the applicable method shown in the plans in
29 layers not to exceed 6" loose unless otherwise permitted. Compact to the density required by
30 Subarticle 235-3(C). Approval of the backfill material is required before its use. Use select
31 material as shown in the contract documents.

32 Take care during backfill and compaction operations to maintain alignment and prevent
33 damage to the joints. Keep backfill free from stones, frozen lumps, chunks of highly plastic
34 clay or other objectionable material.

35 Grade and maintain all pipe backfill areas in such a condition that erosion or saturation will
36 not damage the pipe foundation or backfill.

37 Excavatable flowable fill may be used for backfill when approved by the Engineer. When
38 using excavatable flowable fill, ensure that the pipe is not displaced and does not float during
39 backfill. Submit methods for supporting the pipe and material placement to the Engineer for
40 review and approval.

41 Do not operate heavy equipment over any pipe until it has been properly backfilled with at
42 least 3 ft of cover. Place, maintain and finally remove the required cover that is above the
43 proposed finished grade. Remove and replace pipe that becomes misaligned, shows excessive
44 settlement or has been otherwise damaged by the Contractor's operations.

Section 300

1 **300-8 INSPECTION AND MAINTENANCE**

2 Before final acceptance, the Engineer will perform random video camera and or mandrel
3 inspections to ensure proper jointing and that deformations do not exceed allowable limits.
4 Replace pipes having cracks greater than 0.1" or deflections greater than 7.5%. Repair or
5 replace pipes with cracks greater than 0.01", exhibiting displacement across a crack,
6 exhibiting bulges, creases, tears, spalls or delamination. Maintain all pipe installations in
7 a condition such that they will function continuously from the time the pipe is installed until
8 the project is accepted.

9 **300-9 MEASUREMENT AND PAYMENT**

10 No measurement will be made of any work covered by this section except as listed below.
11 Removal and disposal of existing pavement and unsuitable material above the pipe invert are
12 a part of the excavation for the new pipe culvert installation. Repair of the pavement will be
13 made in accordance with Section 654. Placing, maintaining and removing the required cover
14 is incidental to the work of this section. Removing and replacing pipe that becomes
15 misaligned, shows excessive settlement or has been otherwise damaged by the Contractor's
16 operations is incidental to the work of this section.

17 **(A) Using Local Material**

18 *Undercut Excavation* is all excavation removed by undercutting below the bottom of the
19 trench as staked. *Undercut Excavation* will be measured as the actual number of cubic
20 yards of undercut excavation, measured in its original position and computed by the
21 average end area method, that has been removed as called for in the contract and will be
22 paid at double the contract unit price for *Unclassified Excavation* in accordance with
23 Article 225-7.

24 Local material used for conditioning the foundation will be measured and paid in
25 accordance with Article 225-7 for *Unclassified Excavation* or in accordance with
26 Article 230-5 for *Borrow Excavation* depending on the source of the material.

27 Local material used to replace pipe undercut excavation will be measured and paid in
28 accordance with Article 225-7 or Article 230-5.

29 **(B) Using Other Than Local Material**

30 No measurement and payment will be made for *Undercut Excavation*. The material used
31 to replace pipe undercut excavation will be classified as foundation conditioning material.

32 *Foundation Conditioning Material, Minor Structures* will be measured and paid as the
33 actual number of tons of this material weighed in trucks on certified platform scales or
34 other certified weighing devices.

35 No direct payment will be paid for *Undercut Excavation*. Payment at the contract unit
36 price for *Foundation Conditioning Material, Minor Structures* will be full compensation
37 for all work of pipe undercut excavation.

38 **(C) Foundation Conditioning Geotextile**

39 *Foundation Conditioning Geotextile* will be measured and paid in square yards. The
40 measurement will be based on the theoretical calculation using length of pipe installed
41 and two times the standard trench width. No separate measurement will be made for
42 overlapping geotextile or the vertical geotextile dimensions required to encapsulate the
43 foundation conditioning material.

(D) Bedding and Backfill with Select Material

No measurement will be made for select bedding and backfill material required in the contract documents. The select bedding and backfill material will be included in the cost of the installed pipe.

Where unclassified excavation or borrow material meets the requirements for select bedding and backfill and is approved for use by the Engineer, no deductions will be made to these pay items to account for use in the pipe installation.

Payment will be made under:

Pay Item	Pay Unit
Foundation Conditioning Material, Minor Structures	Ton
Foundation Conditioning Geotextile	Square Yard

SECTION 305 DRAINAGE PIPE

305-1 DESCRIPTION

Where shown in the plans, the Contractor may use reinforced concrete pipe, aluminum alloy pipe, aluminized corrugated steel pipe, HDPE pipe or PVC pipe in accordance with the following requirements.

305-2 MATERIALS

Refer to Division 10.

Item	Section
Aluminized Corrugated Steel Pipe	1032-3(A)(7)
Corrugated Aluminum Alloy Pipe	1032-2(A)
Corrugated HDPE Pipe	1032-7
Elbows	1032
PVC Pipe	1032-8
Reinforced Concrete Pipe, Class II or III	1032-6(B)

Corrugated steel pipe will not be permitted in counties listed in Article 310-2.

Only pipe with smooth inside walls will be allowed for storm drain systems. Define "storm drain systems" as pipe under curb and gutter, expressway gutter and shoulder berm gutter that connects drainage structures and is not open ended.

305-3 CONSTRUCTION METHODS

Install pipe culverts in accordance with Section 300. Where allowed by the plans, use any of the several alternate pipes shown herein, but only one type of pipe and elbow will be permitted between drainage structures or for the entire length of a cross line pipe.

305-4 MEASUREMENT AND PAYMENT

___" *Drainage Pipe* will be measured and paid as the actual number of linear feet of pipe that has been incorporated into the completed and accepted work. Measurement of pipe will be made by counting the number of joints used and multiplying by the length of the joint to obtain the number of linear feet of pipe installed and accepted. Measurements of partial joints will be made along the longest length of the partial joint to the nearest 0.1 ft. Select bedding and backfill material will be included in the cost of the installed pipe.

___" *Drainage Pipe Elbow* will be measured and paid in units of each.

Section 310

1 Payment will be made under:

Pay Item

— " Drainage Pipe
— " Drainage Pipe Elbows

Pay Unit

Linear Foot
Each

2
3

**SECTION 310
PIPE CULVERTS**

4 **310-1 DESCRIPTION**

5 Furnish and install drainage pipe at locations and size called for in the contract documents.
6 The work includes construction of joints and connections to other pipes, endwalls and
7 drainage structures.

8 **310-2 MATERIALS**

9 Refer to Division 10.

Item

Concrete Pipe Tees and Elbows
Corrugated Aluminum Alloy Pipe Culvert
Corrugated Aluminum Alloy Pipe Tees and Elbows
Corrugated Steel Culvert Pipe and Pipe Arch
Corrugated Steel Eccentric Reducers
Corrugated Steel Pipe Tees and Elbows
HDPE Smooth Lined Corrugated Plastic Pipe
Precast Concrete Pipe End Sections
Prefabricated Corrugated Steel Pipe End Sections
PVC Pipe
Reinforced Concrete Pipe Culvert

Section

1032-6(D)
1032-2(A)
1032-2(B)
1032-3(A)
1032-3(D)
1032-3(C)
1032-7
1032-6(C)
1032-3(B)
1032-8
1032-6(B)

10 Use suppliers of metal pipe culverts, fittings and all other accessories covered by this section
11 that meet the Department’s Brand Certification program requirements for metal pipe culverts
12 and are listed on the Materials and Tests Unit’s pre-approved list for suppliers of metal pipe
13 culvert. The pre-approved list is available on the Department’s website.

14 Do not use plain galvanized or aluminized corrugated steel pipe in the following counties:

15 Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus,
16 Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover,
17 Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrell and Washington.

18 **310-3 PIPE INSTALLATION**

19 Install pipe, pipe tees and elbows according to Section 300.

20 **310-4 SIDE DRAIN PIPE**

21 Define “side drain pipe” as storm drain pipe running parallel to the roadway to include pipe in
22 medians, outside ditches, driveways and under shoulder berm gutter along outside shoulders
23 greater than 4 ft wide.

24 Where shown in the plans, side drain pipe may be Class II reinforced concrete pipe,
25 aluminized corrugated steel pipe, corrugated aluminum alloy pipe, HDPE pipe or PVC pipe.
26 Use of corrugated steel pipe is restricted in the counties listed in Article 310-2. Install side
27 drain pipe in accordance to Section 300. Cover for side drain pipe shall be at least one foot.

1 **310-5 PIPE END SECTIONS**

2 Choose which material to use for the required end sections. Both corrugated steel and
 3 concrete pipe end sections will work on concrete pipe, corrugated steel pipe and HDPE
 4 smooth lined corrugated plastic pipe.

5 **310-6 MEASUREMENT AND PAYMENT**

6 *Pipe* will be measured and paid as the actual number of linear feet of pipe that has been
 7 incorporated into the completed and accepted work. Measurement of pipe will be made by
 8 counting the number of joints used and multiplying by the length of the joint to obtain the
 9 number of linear feet of pipe installed and accepted. Measurements of partial joints will be
 10 made along the longest length of the partial joint to the nearest 0.1 ft. Select bedding and
 11 backfill material will be included in the cost of the installed pipe.

12 *Pipe End Sections, Tees, Elbows and Eccentric Reducers* will be measured and paid as the
 13 actual number of each of these items incorporated into the completed and accepted work.

14 Payment will be made under:

Pay Item	Pay Unit
___" R.C. Pipe Culverts, Class ____	Linear Foot
___" x ___" x ___" R.C. Pipe Tees, Class ____	Each
___" R.C. Pipe Elbows, Class ____	Each
___" C.A.A. Pipe Culvert, ___" Thick	Linear Foot
___" x ___" x ___" C.A.A. Pipe Tees, ___" Thick	Each
___" C.A.A. Pipe Elbows, ___" Thick	Each
___" C.S. Pipe Culverts, ___" Thick	Linear Foot
___" x ___" C.S. Pipe Arch Culverts, ___" Thick	Linear Foot
___" x ___" x ___" C.S. Pipe Tees, ___" Thick	Each
___" C.S. Pipe Elbows, ___" Thick	Each
___" x ___" C.S. Eccentric Reducers, ___" Thick	Each
___" HDPE Pipe Culverts	Linear Foot
___" PVC Pipe Culverts	Linear Foot
___" Side Drain Pipe	Linear Foot
___" Side Drain Pipe Elbows	Each
___" Pipe End Section	Each

15

SECTION 330

16

WELDED STEEL PIPE17 **330-1 DESCRIPTION**

18 This work shall consist of furnishing and installing welded steel pipe by trenchless methods as
 19 shown in the contract and as directed.

20 **330-2 MATERIALS**

21 Refer to Division 10.

Item	Section
Welded Steel Pipe	1032-5

22 Use suppliers of metal pipe culverts, fittings and all other accessories covered by this section
 23 that meet the Department's Brand Certification program requirements for metal pipe culverts
 24 and are listed on the Materials and Tests Unit's pre-approved list for suppliers of metal pipe
 25 culvert. The pre-approved list is available on the Department's website.

Section 340

1 **330-3 PIPE INSTALLATION**

2 Install the pipe by trenchless construction, true to line and grade and so settlement does not
3 occur. Fill all voids around the pipe. Replace installations that become damaged or have to
4 be abandoned.

5 Conduct a pre-construction meeting in the presence of the Engineer at least 48 hours before
6 the beginning of the pipe installation. The meeting shall consist of, but not be limited to:

- 7 (A) Reviewing all installation methods to install the pipe true to the line and grade given,
- 8 (B) Methods to insure there is no settlement of the pipe or of the completed roadway section,
9 and
- 10 (C) Methods for filling any potential voids around the pipe.

11 **330-4 MEASUREMENT AND PAYMENT**

12 ___" *Welded Steel Pipe, ___" Thick, Grade B in Soil* will be measured and paid as the actual
13 number of linear feet of pipe measured along the flow line to the nearest foot, which has been
14 installed in soil.

15 ___" *Welded Steel Pipe, ___" Thick, Grade B Not in Soil* will be measured and paid as the actual
16 number of linear feet of pipe measured along the flow line to the nearest foot which has been
17 installed in non-soil, as observed and confirmed by the Engineer. Non-soil is defined as all
18 material other than soil. The Contractor shall request and obtain the Engineer’s observation
19 and confirmation of the limits of the installation not in soil before and during the installation
20 of the pipe or portion of the pipe not in soil.

21 Failure of the Contractor to request and obtain the Engineer’s observation and confirmation of
22 the limits of the pipe not in soil before and during the installation will result in the payment at
23 the unit price for ___" *Welded Steel Pipe, ___" Thick, Grade B in Soil*.

24 Such payment will include, but is not limited to, furnishing all labor, tools, equipment,
25 materials and incidentals, miscellaneous grading or excavation necessary to complete the
26 work. Installations that become damaged or are abandoned will be replaced at no cost to the
27 Department.

28 Payment will be made under:

Pay Item	Pay Unit
___" <i>Welded Steel Pipe, ___" Thick, Grade B in Soil</i>	Linear Foot
___" <i>Welded Steel Pipe, ___" Thick, Grade B Not in Soil</i>	Linear Foot

29 **SECTION 340**
30 **PIPE REMOVAL**

31 **340-1 DESCRIPTION**

32 Remove and dispose of all existing roadway drainage pipe, including flared end sections,
33 where the removal of the existing pipes is required by the plans or as directed. Unless
34 otherwise indicated in the plans, this work excludes the removal and disposal of any existing
35 public or private water or sewage pipe or subsurface and shoulder drain pipe.

36 The Contractor has the option of leaving pipes in place and filling with flowable fill.

37 **340-2 MATERIALS**

38 Refer to Division 10.

Item	Section
Chemical Admixtures	1024-3
Fine Aggregate	1014-1
Flowable Fill	1000-6

Item	Section
Fly Ash	1024-5
Portland Cement	1024-1
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Water	1024-4

- 1 For fine aggregate, bottom ash may be used with permission of the Engineer.
- 2 For chemical admixtures, high-air generators or foaming agents may be used instead of
3 conventional concrete air-entraining agents with the permission of the Engineer.
- 4 For fly ash, certain requirements of this article and ASTM C618 may be waived with the
5 permission of the Engineer.

6 **340-3 CONSTRUCTION METHODS**

- 7 Remove existing pipe when so designated in the plans or as directed. When an existing pipe
8 is encountered that is not shown in the plans, do not remove until the Engineer is notified of
9 its presence and has directed its removal.
- 10 Remove pipe in sections so traffic is maintained. Remove existing pipe so nearby facilities
11 will not be damaged.
- 12 Backfill the area disturbed by the removal of an existing pipe in accordance with the *Standard*
13 *Specifications* applicable to the adjacent construction.
- 14 Salvaged pipe is the property of the Contractor unless otherwise indicated by the contract.
- 15 Discharge flowable fill material directly from the truck into the space to be filled or by other
16 approved methods. The mix may be placed full depth or in lifts as site conditions warrant.

17 **340-4 MEASUREMENT AND PAYMENT**

- 18 *Pipe Removal* will be measured and paid as the actual number of linear feet of pipe and flared
19 end sections, measured to the nearest 0.1 ft that has been removed in accordance with this
20 section. No measurement and payment will be made for pipe removal when a new pipe is
21 placed back in the same trench.
- 22 *Flowable Fill* will be measured and paid as the item for which it was substituted. In no case
23 will payment for the use of flowable fill as a substitute be made for more than one deleted
24 item of work.
- 25 Any additional backfill material that is necessary will be paid at the contract unit price for
26 *Unclassified Excavation* in accordance with Article 225-7 or at the contract unit price for
27 *Borrow Excavation* in accordance with Article 230-5, depending on the source of the material.
- 28 Payment includes but is not limited to removing pipe, hauling pipe and all excavating and
29 backfilling that may be necessary.
- 30 Payment will be made under

Pay Item	Pay Unit
Pipe Removal	Linear Foot

Section 350

**SECTION 350
PIPE CLEAN OUT**

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350-1 DESCRIPTION

Clean out silt accumulations and other debris from existing drainage pipes at locations shown in the plans and as directed.

350-2 CONSTRUCTION METHODS

Use a pipe clean out method that does not damage the existing pipe.

350-3 MEASUREMENT AND PAYMENT

Pipe Clean Out will be measured and paid as the actual number of existing pipes, structure to structure, cleaned out and accepted, except where the work of cleaning out the pipe was made necessary by the Contractor's negligence in taking appropriate erosion control measures. Such price and payment will be full compensation for cleaning out existing pipe and disposing of all silt and debris.

Payment will be made under:

Pay Item	Pay Unit
Pipe Clean Out	Each

DIVISION 4 MAJOR STRUCTURES

SECTION 400 TEMPORARY STRUCTURES

400-1 DESCRIPTION

Furnish any design calculations and drawings required; furnish members and deck materials for structures and any other materials necessary; erect, maintain, remove and dispose of temporary structures required for the maintenance of pedestrian, highway and other traffic. Construct temporary structures in accordance with the contract. Maintain traffic over the temporary structure in accordance with Division 11.

400-2 MATERIALS

Use materials for temporary structures that conform to Division 10 or previously used materials conforming to the contract. Obtain approval for the use of salvaged materials and materials not covered by Division 10 before their use. Unless otherwise specified, untreated timber is allowed.

400-3 PLANS

(A) Furnishing Plans

Use the plans for the structure furnished by the Department or submit a design in accordance with Subarticle 400-3(B).

Design the structure when the plans furnished by the Department do not include detail plans for the structure. For all Contractor designs, furnish one set of design calculations and 11 sets of detail drawings of the structure in accordance with Subarticle 400-3(B).

Submit detail drawings and design calculations for temporary structures for review and comment before beginning work. Do not perform any work until the detail drawings are reviewed and accepted. Acceptance of such drawings does not relieve the Contractor of any responsibility for safely and continuously maintaining traffic.

(B) Design Requirements for Contractor Furnished Drawings

Provide temporary structures of such carrying capacity, dimensions, grades and alignment as required by the contract or as directed. Design temporary structures carrying highway and pedestrian traffic in accordance with the *AASHTO LRFD Bridge Design Specifications*. Ensure an engineer licensed by the State of North Carolina designs and details the temporary structure. Construct the temporary structure in accordance with this design.

Indicate in the plans, the specifications for the materials used in the temporary structure.

400-4 CONSTRUCTION METHODS

Construct and maintain temporary structures to adequately and safely carry traffic during the entire period for which they are required.

Remove and dispose of the temporary structures after they are no longer required in accordance with Article 402-2.

Upon removal of the temporary structure, all material furnished by the Contractor for use in this structure shall remain the property of the Contractor unless otherwise provided in the contract.

Section 402

1 Unless otherwise specified in the contract, remove temporary piling to the streambed level or
2 to one foot below existing ground.

3 **400-5 MEASUREMENT AND PAYMENT**

4 The price and payment below will be full compensation for all work required to provide
5 temporary structures including, but not limited to, those items contained in Article 400-1.

6 The work covered by this section will be paid at the contract lump sum price for *Construction,*
7 *Maintenance and Removal of Temporary Structure at Sta. _____.*

8 Payment will be made under:

Pay Item	Pay Unit
Construction, Maintenance and Removal of Temporary Structure at Sta. _____	Lump Sum

9 **SECTION 402**
10 **REMOVAL OF EXISTING STRUCTURES**

11 **402-1 DESCRIPTION**

12 Excavate as necessary to remove the structure; dismantle, salvage and stockpile materials and
13 components of the structure and preserve those portions that should remain intact and dispose
14 of waste and debris.

15 Maintain traffic over the existing structure in accordance with Division 11 unless otherwise
16 stipulated by the contract. Comply with the posted load limits of the existing structure. The
17 maintenance of the existing structure, if required, will be performed by Department forces.

18 **402-2 REMOVAL OF EXISTING STRUCTURE**

19 **(A) General**

20 Use approved methods and operations for removal of structures. Upon removal, all
21 materials become the property of the Contractor unless otherwise indicated in the
22 contract. Dispose of waste and debris from the structures in accordance with
23 Section 802.

24 Perform removal operations while preventing damage to adjacent property. Protect new
25 construction during blasting or other operations necessary for the removal of the existing
26 structure.

27 Unless otherwise required by the contract, remove substructures down to the streambed
28 or one foot below the natural ground surface. Remove the substructure as necessary to
29 avoid interference with construction of the proposed structure.

30 Prevent erosion of soil and silting of rivers, streams, lakes, reservoirs, water
31 impoundment, ground surfaces or other property. Do not deposit excavated materials and
32 do not construct earth dikes or other temporary earth structures in rivers, streams or
33 impoundment, or so near to such waters that they are carried into any river, stream or
34 impoundment by stream flow or surface runoff. Limit the use of equipment in any body
35 of water to those operations that are impossible or impractical to perform in any other
36 way and control them as to minimize erosion and siltation. Submit, and await approval
37 for, a plan for bridge demolition for bridges over water before beginning removal. Do
38 not drop components of structures into any body of water. Remove these existing bridges
39 by sawing or other non-shattering methods. Remove any component of a structure from
40 the water so as to minimize siltation.

(B) Requirements for Materials Which Remain the Property of the Department

Pile materials salvaged from the structure neatly on the right of way at locations as directed.

Do not use any materials, either temporarily or permanently, which are removed from the structure unless so permitted by the contract.

Remove structural materials carefully without damage.

Do not use explosives to remove concrete floor slabs from steel superstructures that remain the property of the Department.

(C) Requirements for Partial Removal

Perform partial removal true to the lines indicated in the plans. Submit, and await approval for, a plan for partial removal of bridges before beginning removal. Do not remove concrete by blasting or other method that may cause damage to the concrete or reinforcement that is used in the completed structure.

Use equipment and methods to remove portions of a concrete structure undergoing widening which are sufficient to obtain plan lines and slopes without undue spalling at edges of the concrete. Do not use an iron ball or pile hammer to remove portions of a concrete structure undergoing widening.

402-3 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for all items required to remove existing structures including, but not limited to, those items contained in Article 402-1.

When the contract includes the item of *Removal of Existing Structure at Station ____*, the work of removing the structure will be paid at the contract lump sum price for this item.

When the contract includes the item of *Removal of Existing Structures at Station ____*, the work of removing the structures will be paid at the contract lump sum price for this item.

Payment will be made under:

Pay Item	Pay Unit
Removal of Existing Structure at Station ____	Lump Sum
Removal of Existing Structures at Station ____	Lump Sum

**SECTION 410
FOUNDATION EXCAVATION**

410-1 DESCRIPTION

Excavate any material as necessary for the construction of foundations and end bent caps for bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts and box culverts without floor slabs in accordance with the contract or as directed. Excavate, perform exploratory drilling at footings to a depth not to exceed 5 ft, blast, drain, divert water, bail and pump. Provide and remove bracing, shoring, sheeting, cribbing and cofferdams; substructure scour protection, subsurface drainage and drawings; and backfill including hauling and disposal of materials.

Do not deposit excavated materials or construct earth dikes or other temporary earth structures in rivers, streams or impoundment or so near to such waters that they are carried into any river, stream or impoundment by stream flow or surface runoff. As an exception to the above, obtain written approval for the use of confined earth materials in cofferdams for structure foundations.

Section 410

1 410-2 MATERIALS

2 Refer to Division 10.

Item	Section
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Stone, No. 78M	1005
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Subdrain Fine Aggregate	1044-1
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3 410-3 FOUNDATION EXCAVATION

4 Notify the Engineer a sufficient time before beginning the excavation to allow measurements
5 of the undisturbed ground.

6 Where necessary for safety, slope, shore, brace or protect by cofferdams the foundation
7 openings in accordance with State and local safety standards. Perform foundation excavation
8 and related work in such sequence that no portion of the structure is endangered by
9 subsequent operations. Adequately protect completed portions of a structure during blasting
10 operations.

11 Consider the dimensions and elevations of footings, as shown in the plans as approximate
12 only. The Engineer may order, in writing, such changes in dimensions or elevations of
13 footings as necessary to secure a satisfactory foundation.

14 Notify the Engineer after excavating each foundation. Do not place concrete before obtaining
15 approval for the excavation depth, the character of the foundation and permission to proceed.
16 Perform drilling as may be required by the Engineer to obtain information as to the depth to
17 which the rock or other hard foundation material extends below the bottom of the footing.

18 Clean all rock or other hard foundation material of all loose material and cut to a firm surface,
19 either level, stepped or serrated, as directed. Clean out all seams and fill with concrete,
20 mortar or grout. Remove all loose and disintegrated rock and thin strata. Leave the rock
21 surface in a rough condition to form an adequate key against lateral movement of the footing.

22 When the footing rests on an excavated surface other than rock, take special care not to
23 disturb the bottom of the excavation until immediately before placing reinforcing steel and
24 concrete. Remove foundation material softened and weakened by exposure and inundation
25 down to sound, solid material before placing steel and concrete.

26 When using piles or drilled piers, complete the excavation of each pit before installing piles or
27 piers.

28 When water or other unsuitable material is encountered, pile driving liquefies the soil, or the
29 bed is otherwise unsuitable as determined by the Engineer, remove the material as required
30 and backfill to the required elevation with an approved granular material. Such work will be
31 paid as extra work in accordance with Article 104-7.

32 410-4 COFFERDAMS

33 (A) General

34 The term cofferdam designates any temporary or removable structure constructed to hold
35 the surrounding earth, water or both, out of the excavation. It includes timber cribs, any
36 type of sheet piling, removable steel shells or similar structures, all necessary bracing and
37 the use of pumping wells or well points for the same purpose. Ensure cofferdams located
38 in bodies of water are designed, detailed and sealed by an engineer licensed by the State
39 of North Carolina when the distance from the water surface to the bottom of the
40 excavation is 5 ft or greater.

(B) Construction

Design and construct cofferdams to adequate depths and heights, safely and as watertight as is necessary for the proper performance of the work. Provide interior dimensions of cofferdams as to give sufficient clearance for the construction and inspection of forms and to permit pumping outside the forms. Provide at least 5 ft of clearance between the proposed edge of footing and inside face of cofferdam when a keyed footing is required and at least 3 ft when a keyed footing is not required. Right, rest or enlarge cofferdams that are tilted or moved laterally during the process of sinking to provide the necessary clearance.

Construct cofferdams to protect plastic concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. Do not leave timber or bracing in cofferdams that could extend into the substructure concrete without permission.

(C) Removal

After the completion of the substructure, unless otherwise provided in the contract, remove cofferdams with all sheeting and bracing to the stream bed or one foot below existing ground. Take care not to disturb or injure the finished concrete.

410-5 PUMPING

Perform pumping operations in accordance with Article 414-5.

410-6 PRESERVATION OF CHANNEL

Unless otherwise required by the contract or permitted by the Engineer, do not excavate in stream channels outside of cofferdams. Do not disturb the natural stream bed adjacent to the structure without permission. Backfill any excavation or dredging made at the site of the structure outside of the cofferdam limits to the original ground surface or river bed with approved material.

Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted.

410-7 UTILIZATION OF EXCAVATED MATERIAL

Use suitable excavated material as backfill. Use suitable material that is not required for backfill to form embankments, subgrades or shoulders. Furnish disposal areas for excavated unsuitable materials and suitable materials not required in connection with other work included in the contract. Do not place excavated material in a stream or other body of water or wetland.

Do not deposit excavated material at any time so as to endanger the partly finished structure, either by direct pressure, indirectly by overloading banks adjacent to the operations or in any other manner.

410-8 BACKFILLING AND FILLING

Use approved material for backfill that is free from large or frozen lumps, wood or other undesirable material. Where there is not an adequate quantity of suitable backfill material available from the excavation, provide suitable backfill material compensated in accordance with Article 410-10.

Refill all excavated spaces, not filled with permanent work, with earth up to the ground surface existing before the excavation. Place backfill to provide adequate drainage as soon as concrete surfaces are finished in accordance with Subarticle 420-17(B) and the concrete has been inspected and approved. The Engineer has the authority to suspend all operations until such backfilling is acceptably completed.

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1 Eliminate any slope adjacent to the excavation for abutments, wingwalls and retaining walls
2 by stepping or serrating to prevent wedge action.

3 Place and compact all portions of the backfill that become a part of roadway typical sections
4 or their foundations in accordance with Subarticles 235-3(B) and 235-3(C). Place all other
5 portions of the backfill in layers not more than 10" in depth of loose measure and compact to
6 a density comparable to the adjacent undisturbed material.

7 Place backfill or embankment material simultaneously to approximately the same elevation on
8 both sides of an abutment, pier or wall. If conditions require placing backfill or embankment
9 higher on one side, do not place the additional material on the higher side until the concrete
10 develops the minimum specified strength for the class of concrete required for the structure as
11 specified in Table 1000-1.

12 Do not place backfill or embankment behind the walls of concrete culverts, abutments of
13 bridges other than rigid frames or abutments of rigid frame structures until the top slab is
14 placed and has developed the minimum compressive strength required by Article 420-20.
15 Place backfill and embankment simultaneously behind opposite abutments of rigid frames or
16 sidewalls of culverts.

17 Place backfill to not cause excess lateral forces against the structure by heavy equipment or
18 from earth masses transmitting pressures caused by earth moving equipment. Place backfill
19 immediately adjacent to the structure by hand operated mechanical tampers. Do not operate
20 heavy earth moving equipment within 10 ft of the structure in backfilling operations.

21 **410-9 BLASTING ADJACENT TO HIGHWAY STRUCTURES**

22 Conduct blasting operations adjacent to highway structures in accordance with the following
23 requirements.

24 Submit and await approval of a blasting plan before conducting any blasting operation.

25 Do not conduct blasting operations within 60 ft of any structure until the concrete strength
26 reaches 2,400 psi. After the concrete achieves a strength of 2,400 psi, limit the maximum
27 peak particle velocity to 4 in/sec measured at the closest structure extremity.

28 For multi-column bents with column heights up to 40 ft and a combined span length for the
29 2 adjacent spans of 160 ft or less, adhere to the following criteria:

30 (A) Do not blast within 6 ft without obtaining prior written approval.

31 (B) At distance of 6 ft to 10 ft, do not use a quantity of explosives more than 0.5 lb per delay
32 period.

33 (C) From 11 ft to 60 ft, use a maximum charge weight per delay of 0.5 lb and 0.5 lb of
34 explosives per foot of distance over 10 ft.

35 No vibration measurements are required if the above criteria are met. If unable to meet the
36 above criteria, monitor the structure with an engineering seismograph to determine whether
37 the 4 in/sec limit is exceeded. If the 4 in/sec limit is exceeded, the Engineer will evaluate
38 each subsequent blast, and if deemed necessary, will apply more restrictive controls than
39 those above to prevent damage.

40 **410-10 MEASUREMENT AND PAYMENT**

41 Payment of blasting operations is included in the bid price for *Foundation Excavation* at the
42 affected substructure unit.

(A) Foundation Excavation on a Cubic Yard Basis

When the contract calls for payment of *Foundation Excavation* on a cubic yard basis, it will be measured and paid as the actual number of cubic yards of materials, measured in their original position within the limits described below and computed by the average end area method, that are acceptably excavated.

The upper limits for measurement are the actual ground surface at the time of starting work, except where the excavation is performed in cut areas excavated under Section 225, the upper limits are the roadway plan typical section. For keyed footings the upper limits of the keyed section are as shown in the plans. Define a “keyed footing” as a footing placed without forms for the keyed depth in an excavation whose sides, as near as practical, are located at the neat line dimensions of the footing and are vertical.

When the foundation material is other than rock, the lower limits for measurement are the elevation of the bottom of footing as established by the plans or as directed. When the foundation material is rock, the lower limits for measurement are the actual rock elevations after the foundation is approved.

As an exception to the lower limits established above, when in the opinion of the Engineer excess excavation is performed due to carelessness or negligence on the part of the Contractor, the Engineer notifies the Contractor of that portion of the excavation which is not measured for payment.

Horizontal limits for measurement are established by vertical planes located 18" outside of the neat line dimensions of the footing as established by the plans or directed in writing by the Engineer. For keyed footings the horizontal limits for measurement of the keyed section are established by vertical planes located at the neat line dimensions of the footing as established by the plans or directed in writing.

Measurement includes mud, muck or similar semi-solid material within the limits described above provided such material is present at the time excavation begins and cannot be drained away or pumped without the use of a jet or nozzle.

(1) No measurement is made of the following excavation, as such excavation is incidental to the work being performed:

- (a) Excavation necessary to construct end bent caps and the berm adjacent to the cap.
- (b) Excavation necessary to construct pile encasement.
- (c) Excavation outside of the limits described in this subarticle.
- (d) Excavation necessary from heaving of a foundation due to the driving of piles.
- (e) Excavation necessary from overbreaks or slides.
- (f) Mud, muck or similar semi-solid material which can be drained away or pumped without the use of a jet or nozzle.
- (g) Excavation made before the Engineer makes measurements of the undisturbed ground.
- (h) Excavation necessary due to exposure or inundation allowed by the Contractor or negligence on the part of the Contractor.

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1 (2) *Foundation Excavation* will be paid at the contract unit price per cubic yard for
2 *Foundation Excavation* except where the Engineer directs the Contractor in writing
3 to excavate below the original plan elevation of the bottom of the footing. Payment
4 for such excavation will be made as follows:

5 (a) For excavation made below the original plan elevation of the bottom of the
6 footing to an elevation 3 ft below such plan elevation, payment will be made at
7 the contract unit price per cubic yard for *Foundation Excavation*.

8 (b) For excavation made below an elevation 3 ft below the original plan elevation of
9 the bottom of the footing but not more than 6 ft below such plan elevation,
10 payment will be made at 150% of the contract unit price per cubic yard for
11 *Foundation Excavation*.

12 (c) For excavation made below an elevation 6 ft below the original plan elevation of
13 the bottom of the footing, payment will be made as extra work in accordance
14 with Article 104-7.

15 (d) In areas where piles have been driven, removal of material and backfilling with
16 approved granular material in accordance with Article 410-3 will be paid as
17 extra work in accordance with Article 104-7.

18 (B) Foundation Excavation on a Lump Sum Basis

19 When the contract calls for payment of *Foundation Excavation* on a lump sum basis, no
20 measurement will be made of any foundation excavation made at such locations.

21 The prices and payments below will be full compensation for all items required to
22 complete foundation excavation.

23 (1) When the contract calls for payment on a lump sum basis, payment will be made at
24 the contract lump sum price for *Foundation Excavation for Bent No. ____ at*
25 *Station ____ or Foundation Excavation for End Bent No. ____ at Station ____*
26 except as otherwise provided below.

27 (2) Where the Engineer directs the Contractor to excavate below the original plan
28 elevation of the bottom of the footing by a distance which is less than 3 ft the
29 character of the work will not be considered to be materially changed and no
30 additional compensation will be allowed for the foundation excavation at such
31 location.

32 (3) Where the Engineer directs the Contractor in writing to excavate more than 3 ft
33 below the original plan elevation of the bottom of the footing, payment for such
34 excavation will be made as extra work in accordance with Article 104-7.

35 (C) Furnishing and Hauling Backfill Material

36 Where it is necessary to provide backfill material from sources other than excavated areas
37 or borrow sources used in connection with other work in the contract, payment for
38 furnishing and hauling such backfill material will be paid as extra work in accordance
39 with Article 104-7. Placing and compacting such backfill material is not extra work but
40 is incidental to the work being performed.

41 When the Contractor has been directed by the Engineer to drill in the vicinity of a footing
42 to obtain subsurface information, such drilling in excess of a 5 ft depth will be paid as
43 extra work in accordance with Article 104-7.

44 When so used, no additional payment will be made for use of the material under other
45 pay items or for stockpiling the material for use under other pay items.

1 Payment will be made under:

Pay Item	Pay Unit
Foundation Excavation	Cubic Yard
Foundation Excavation for Bent No. ____ at Station ____	Lump Sum
Foundation Excavation for End Bent No. ____ at Station ____	Lump Sum

2

SECTION 411 DRILLED PIERS

3

4 411-1 DESCRIPTION

5 Construct drilled piers consisting of cast-in-place reinforced concrete cylindrical sections in
6 excavated holes typically stabilized with casings or slurry. Provide permanent casings,
7 standard penetration tests, integrity testing and assistance with the shaft inspection device as
8 noted in the plans. Construct drilled piers with the required resistances and dimensions in
9 accordance with the contract and accepted submittals. Use a prequalified Drilled Pier
10 Contractor to construct drilled piers.

11 Define "excavation" and "hole" as a drilled pier excavation and "pier" as a drilled pier.
12 Define "rock" as a continuous intact natural material in which the penetration rate with a rock
13 auger is less than 2" per 5 minutes of drilling at full crowd force. This definition excludes
14 discontinuous loose natural materials such as boulders and man-made materials such as
15 concrete, steel, timber, etc. and is not for measurement and payment purposes. See
16 Article 411-7 for measurement and payment of drilled piers.

17 411-2 MATERIALS

18 Refer to Division 10.

Item	Section
Grout, Nonshrink	1003
Portland Cement Concrete, Class Drilled Pier	1000
Reinforcing Steel	1070

19 Provide Type 3 material certifications in accordance with Article 106-3 for permanent casings
20 and roller, chair, steel pipe and cap materials. Store steel materials on blocking at least 12"
21 above the ground and protect it at all times from damage; and when placing in the work make
22 sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials.
23 Load, transport, unload and store drilled pier materials so materials are kept clean and free of
24 damage.

25 (A) Steel Casing

26 Define "casing" as a temporary or permanent casing. Use smooth non-corrugated clean
27 watertight steel casings of ample strength to withstand handling and installation stresses
28 and pressures imposed by concrete, earth, backfill and fluids.

29 (1) Temporary Casings

30 Provide temporary casings with nominal wall thicknesses of at least 0.375" and
31 outside diameters equal to or larger than the design pier diameters for which casings
32 are used.

33 (2) Permanent Casings

34 Use permanent casings with yield strengths of at least 36 ksi and nominal wall
35 thicknesses that meet Table 411-1.

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TABLE 411-1 MINIMUM PERMANENT CASING WALL THICKNESS	
Casing Diameter	Nominal Wall Thickness
< 48"	0.375"
48" - 78"	0.500"
> 78"	0.625"

1 Provide permanent casings with outside diameters equal to the design pier diameters
2 for which casings are used unless larger diameter permanent casings are approved.

3 **(B) Slurry**

4 Define "slurry" as bentonite or polymer slurry. Mix bentonite clay or synthetic polymer
5 with water to form bentonite or polymer slurry.

6 (1) Bentonite Slurry

7 Provide bentonite slurry that meets Table 411-2.

TABLE 411-2 BENTONITE SLURRY REQUIREMENTS^A		
Property	ANSI/API RP^B 13B-1	Requirement
Density ^C (Mud Weight)	Section 4	64.3 - 72.0 lb/cf
Viscosity	Section 6.2 Marsh Funnel	28 - 50 sec/qt
Sand Content	Section 9	≤ 4 % ^D ≤ 2 % ^E
pH	Section 11 Glass Electrode pH Meter ^F	8 - 11

- 8 **A.** Slurry temperature of at least 40°F required
9 **B.** American National Standards Institute/American Petroleum Institute
10 Recommended Practice
11 **C.** Increase density requirements by 2 lb/cf in saltwater
12 **D.** In tanks before pumping slurry into excavations
13 **E.** In excavations immediately before placing concrete
14 **F.** pH paper is also acceptable for measuring pH

15 (2) Polymer Slurry

16 Use a polymer slurry product approved by the Department. Value engineering
17 proposals for other polymer slurry products will not be considered. A list of
18 approved polymer slurry products is available from the Department's website or the
19 Geotechnical Engineering Unit.

20 Provide polymer slurry that meets Table 411-3.

TABLE 411-3 POLYMER SLURRY REQUIREMENTS^A		
Property	ANSI/API RP^B 13B-1	Requirement
Density ^C (Mud Weight)	Section 4	≤ 64 lb/cf
Viscosity	Section 6.2 Marsh Funnel	32 - 135 sec/qt
Sand Content	Section 9	≤ 0.5 % ^{D,E}
pH	Section 11 Glass Electrode pH Meter ^F	8 - 11.5

- 1 **A.** Slurry temperature of at least 40°F required
2 **B.** American National Standards Institute/American Petroleum Institute
3 Recommended Practice
4 **C.** Increase density requirements by 2 lb/cf in saltwater
5 **D.** In tanks before pumping slurry into excavations
6 **E.** In excavations immediately before placing concrete
7 **F.** pH paper is also acceptable for measuring pH

8 **(C) Rollers and Chairs**

9 Use rollers and chairs that are non-metallic and resistant to corrosion and degradation.
10 Provide rollers with the necessary dimensions to maintain the minimum required concrete
11 cover shown in the plans and center rebar cages within excavations. Use chairs of
12 sufficient strength to support rebar cages in excavations and of the size necessary to raise
13 cages off bottom of holes to maintain the minimum required distance shown in the plans.

14 **(D) Steel Pipes and Caps**

15 Use Schedule 40 black steel pipes for access tubes for crosshole sonic logging (CSL).
16 Provide CSL tubes with an inside diameter of at least 1.5". Use CSL tubes with a round,
17 regular inside diameter free of defects and obstructions, including any pipe joints, in
18 order to permit free, unobstructed passage of probes for CSL testing. Provide watertight
19 CSL tubes free of corrosion with clean internal and external faces to ensure a good bond
20 between concrete and tubes. Fit CSL tubes with watertight plastic caps on the bottom
21 and removable caps on top.

22 **411-3 PRECONSTRUCTION METHODS**

23 **(A) Drilled Pier Construction Plan Submittal**

24 Submit the proposed drilled pier construction plan for all drilled piers for acceptance.
25 Provide 2 copies of this plan at least 30 days before starting drilled pier construction. Do
26 not begin drilled pier construction until a construction plan is accepted. Provide detailed
27 project specific information in the drilled pier construction plan that includes the
28 following:

- 29 (1) Overall description and sequence of drilled pier construction;
- 30 (2) List and sizes of equipment including cranes, drill rigs, vibratory and downhole
31 hammers, Kelly bars, augers, core barrels, casings (diameters, thicknesses and
32 lengths), cleanout buckets, air lifts, pumps, slurry equipment, tremies, pump pipes
33 and other equipment;
- 34 (3) Procedures for casing installation and temporary casing removal including how
35 telescoping temporary casings will be removed;

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- 1 (4) If applicable, details of slurry testing and use including intended purpose, product
2 information and additives, manufacturer's recommendations for use, name and
3 contact information for slurry manufacturer's technical representative, mixing and
4 handling procedures and how slurry level will be maintained above the highest
5 piezometric head;
- 6 (5) Methods for drilling and cleaning holes including how cores will be removed and
7 drilling spoils and slurry will be handled and disposed of;
- 8 (6) Details of CSL tubes, caps and joints including pipe size and how tubes will be
9 attached to reinforcing steel;
- 10 (7) Procedures for lifting and setting reinforcing steel including how rebar cages will be
11 supported and centralized;
- 12 (8) Procedures for placing concrete including how tremies and pump pipes will be
13 controlled and contaminated concrete will be contained;
- 14 (9) Concrete mix design that meets Section 1000;
- 15 (10) Approved packaged grout or grout mix design that meets Section 1003;
- 16 (11) CSL Consultant including Field and Project Engineer; and
- 17 (12) Other information shown in the plans or requested by the Engineer.

18 If alternate construction procedures are proposed or necessary, a revised drilled pier
19 construction plan submittal may be required. If the work deviates from the accepted
20 submittal without prior approval, the Engineer may suspend drilled pier construction until
21 a revised plan is accepted.

22 (B) Preconstruction Meeting

23 Before starting drilled pier construction, hold a preconstruction meeting to discuss the
24 installation, monitoring and inspection of the drilled piers. Schedule this meeting after all
25 drilled pier submittals have been accepted and the Drilled Pier Contractor has mobilized
26 to the site. The Resident or Bridge Maintenance Engineer, Bridge Construction
27 Engineer, Geotechnical Operations Engineer, Contractor and Drilled Pier Contractor
28 Superintendent will attend this preconstruction meeting.

29 411-4 CONSTRUCTION METHODS

30 Do not excavate holes, install piles or allow equipment loads or vibrations within 20 ft of
31 completed piers until 16 hours after Drilled Pier concrete reaches initial set.

32 When drilling from a barge, use a fixed template that maintains hole position and alignment
33 during drilled pier construction. Do not use floating templates or templates attached to
34 barges.

35 Check for correct drilled pier alignment and location before beginning drilling. Check
36 plumbness of Kelly bars before beginning and frequently during drilling.

37 Construct drilled piers with the minimum required diameters shown in the plans except for
38 piers constructed with permanent casings and slurry or permanent casings to rock. For these
39 situations, the pier diameter may be 2" less than the design pier diameter shown in the plans.

40 Install drilled piers with tip elevations no higher than shown in the plans or approved by the
41 Engineer. Provide piers with the minimum required tip resistance and, when noted in the
42 plans, penetration into rock.

(A) Excavation

Excavate holes with equipment of the sizes required to construct drilled piers. Use equipment and methods accepted in the drilled pier construction plan or approved by the Engineer. Inform the Engineer of any deviations from the accepted plan.

Use drill rigs with sufficient capacity to drill through soil, rock, boulders, timbers, man-made objects and any other materials encountered and drill 20 ft deeper or 20% longer than the maximum drilled pier length shown in the plans, whichever is greater. Drilling below pier tip elevations shown in the plans may be required to attain sufficient resistance.

Do not use blasting to advance drilled pier excavations. Blasting for core removal is only permitted when approved by the Engineer. Contain and dispose of drilling spoils and waste concrete as directed and in accordance with Section 802. Drilling spoils consist of all materials and fluids removed from excavations.

Stabilize excavations with only casings or slurry and casings except, as approved by the Engineer, portions of excavations in rock. Use casings or slurry in rock if unstable material is anticipated or encountered. Stabilize excavations from beginning of drilling through concrete placement. If excavations become unstable, the Engineer may suspend drilling and require a revised drilled pier construction plan. If it becomes necessary to replace a casing during drilling, backfill the excavation, insert a larger casing around the casing to be replaced or stabilize the excavation with slurry before removing the casing.

When noted in the plans, do not dewater drilled pier excavations. Otherwise, if excavations are in rock, dewater excavations to the satisfaction of the Engineer.

(B) Casings

Provide temporary casings to stabilize holes and protect personnel entering excavations. Permanent casings may be required as noted in the plans. Install permanent casings with tip elevations no deeper than shown in the plans or approved by the Engineer. Additional drilled pier length and reinforcing steel may be required if permanent casings are installed below elevations noted in the plans.

Install casings in continuous sections. Overlap telescoping casings at least 24". Remove casings and portions of permanent casings above the ground line or top of piers, whichever is higher, after placing concrete. Do not cut off permanent casings until Drilled Pier concrete attains a compressive strength of at least 3,000 psi.

When using slurry construction without permanent casings, temporary casings at least 10 ft long are required at top of excavations. Maintain top of casings at least 12" above the ground line.

(C) Slurry Construction

Unless noted otherwise in the plans, slurry construction or polymer slurry is at the Contractor's option.

Use slurry and additives to stabilize holes in accordance with the manufacturer's recommendations. Provide a technical representative employed by the slurry manufacturer to assist and guide the Drilled Pier Contractor onsite during the construction of the first drilled pier. If problems are encountered during drilled pier construction, the Engineer may require the technical representative to return to the site.

Provide documentation that mixing water is suitable for slurry. Use slurry equipment that is sufficient for mixing, agitating, circulating and storing slurry. Thoroughly premix slurry with water in tanks before pumping into excavations. Allow bentonite slurry to hydrate at least 24 hours in tanks before use.

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1 Pump slurry into excavations before encountering water. Maintain slurry level at least
2 5 ft or one pier diameter, whichever is greater, above the highest piezometric head along
3 the drilled pier length. The highest piezometric head is anticipated to be the static water
4 or groundwater elevation. However, the Drilled Pier Contractor is responsible for
5 determining the highest piezometric head for each pier.

6 Maintain the required slurry properties at all times except for sand content. Desand or
7 replace slurry as needed to meet the required sand content in tanks before pumping slurry
8 into excavations and in excavations immediately before placing concrete.

9 (1) Time

10 Agitate bentonite slurry in holes at least every 4 hours. If this 4-hour time limit is
11 exceeded, the Engineer may require holes to be overreamed at least 1" and no more
12 than 3" below casings. Overream holes with grooving tools, overreaming buckets or
13 other approved methods.

14 Construct drilled piers so the maximum time slurry is in contact with uncased
15 portions of holes from drilling through concrete placement does not exceed 36 hours.
16 If this 36 hour time limit is exceeded, the Engineer may require the hole diameter to
17 be enlarged at least 6". If the enlarged hole diameter is greater than the permanent
18 casing diameter, replace casing with a larger permanent casing with an outside
19 diameter equal to the diameter of the enlarged hole.

20 (2) Slurry Testing

21 Define a "sample set" as slurry samples collected from mid-height and within 2 ft of
22 the bottom of slurry tanks or holes. Take a sample set from slurry tanks to test slurry
23 before beginning drilling. Do not pump slurry into excavations until both slurry
24 samples from tanks meet the required slurry properties. Take sample sets from
25 excavations to test slurry at least every 4 hours and immediately before placing
26 concrete. Do not place Drilled Pier concrete until both slurry samples from
27 an excavation meet the required slurry properties. If any slurry test results do not
28 meet the requirements, the Engineer may suspend drilling until both samples from
29 a sample set meet the required slurry properties.

30 Sign, date and submit slurry test reports upon completion of each pier. The
31 Department reserves the right to perform comparison slurry tests at any time.

32 (3) Disposal

33 Comply with all Federal, State and local regulations, as well as the project permits
34 and commitments, when disposing of slurry and drilling spoils mixed with slurry.
35 Contain slurry and drilling spoils and keep out of water at all times.

36 (D) Cleaning and Inspection

37 Provide clean holes with level bottoms so elevations within bottom of holes do not vary
38 by more than 12". Remove soft and loose material from bottom of holes using methods
39 accepted in the drilled pier construction plan or approved by the Engineer. When bottom
40 of holes are not hand cleaned, remove sediment from holes with cleanout buckets, air lifts
41 or pumps.

42 After cleaning is complete, provide all equipment, personnel and assistance required for
43 the Engineer to visually inspect holes from above or by entering excavations. Remove all
44 cleaning and drilling equipment from holes during inspections and do not interfere with
45 inspections.

1 (1) Tip Resistance

2 If the Engineer determines that the material below an excavation does not provide
3 the minimum required tip resistance, increase the drilled pier length and lengthen
4 reinforcing steel as directed. One of the following methods may be required to check
5 the conditions and continuity of material below excavations.

6 (a) Test Hole

7 If excavations are in rock, drill a 1.5" diameter test hole at least 6 ft below
8 bottom of holes for the Engineer to determine the continuity of rock below
9 holes.

10 (b) Standard Penetration Test

11 Standard penetration tests (SPT) may be required as noted in the plans. When
12 required, drive a split-barrel sampler 18" below bottom of holes or to refusal in
13 accordance with ASTM D1586. Perform SPT in holes at least 12" away from
14 casing walls and support drill rods so rods remain vertical and straight. Report
15 the number of blows applied in each 6" increment and provide recovered
16 samples to the Engineer. The Engineer will determine the standard penetration
17 resistance required.

18 (2) Bottom Cleanliness

19 Holes are clean if at least 50% of bottom of holes has less than 0.5" of sediment and
20 no portions of bottom of holes have more than 1.5" of sediment. If bottom of holes
21 does not meet this cleanliness criteria, remove sediment from holes until the
22 Engineer determines holes are clean. One or more of the following methods may be
23 required to inspect the bottom cleanliness of holes.

24 (a) Steel Probe

25 If drilled pier excavations are not dewatered or as directed, provide a #10 rebar
26 steel probe that is 24" long with a flat tip on one end and a non-stretch cable
27 connected to the other end. Provide a cable long enough to lower the steel probe
28 to the bottom of holes for the Engineer to determine the amount of sediment in
29 holes.

30 (b) Shaft Inspection Device

31 The Engineer may use the shaft inspection device (SID) as noted in the plans.
32 The Engineer provides the SID and personnel to operate it. Notify the Engineer
33 at least 2 days before finishing holes that will be inspected with the SID.

34 Assist the Engineer in handling the SID and associated equipment and
35 supporting the SID during inspections. Provide working areas large enough for
36 the SID, associated equipment and SID personnel within reach of the SID cables
37 and clear view of holes being inspected. If necessary, provide a secure location
38 to store the SID and associated equipment onsite overnight.

39 Approximately one hour is required to inspect a hole with the SID after the SID
40 and associated equipment are set up. The Engineer will use the SID to measure
41 the amount of sediment at 5 locations around the bottom of holes.

42 **(E) Reinforcing Steel and Concrete**

43 Assemble rebar cages consisting of bar and spiral reinforcing steel shown in the plans.
44 Securely cross tie reinforcing steel at each intersection with double wire. Attach a chair
45 under each reinforcing bar and rollers near the top and bottom of rebar cages and every
46 10 ft along cages in between. The number of rollers required at each location along rebar
47 cages is one roller per foot of design pier diameter with at least 4 rollers per location.

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1 Space rollers equally around rebar cages at each location. Attach rollers so rollers are
2 supported across 2 adjacent reinforcing bars and will freely rotate when rebar cages are
3 lowered into excavations.

4 If CSL tubes are required, securely attach CSL tubes to spiral reinforcing steel on the
5 inside of rebar cages with at least 3" clearance to reinforcing bars. Extend CSL tubes
6 from 6" above pier tip elevations to at least 2 ft above the ground line or top of permanent
7 casings, whichever is greater. The number of CSL tubes required for each drilled pier is
8 one tube per foot of design pier diameter with at least 4 tubes per pier. Space CSL tubes
9 equally around rebar cages so distances between tubes measured around spiral
10 reinforcing steel are uniform. Install CSL tubes as straight and parallel to each other as
11 possible. Fit caps on top and bottom of CSL tubes.

12 After the Engineer determines that the material below excavations provides the minimum
13 required tip resistance and holes are clean, place rebar cages and then concrete in
14 excavations. Do not rack or distort rebar cages and CSL tubes when lifting and handling
15 cages. Set rebar cages directly on bottom of holes or, as approved by the Engineer, hang
16 cages from permanent casings. When hanging rebar cages, leave devices supporting
17 cages in place until Drilled Pier concrete attains a compressive strength of at
18 least 3,000 psi.

19 Do not delay placing cages or concrete unless excavations are cased to rock or otherwise
20 approved. If delays occur, the Engineer may require removal of rebar cages to reinspect
21 bottom cleanliness of holes. If bottom of holes does not meet the cleanliness criteria in
22 Subarticle 411-4(D)(2), remove sediment from holes until the Engineer determines holes
23 are clean before resetting rebar cages.

24 After placing rebar cages with CSL tubes, remove top caps, fill tubes with clean water
25 and reinstall caps before placing concrete. Check for correct cage position before placing
26 concrete and keep rebar cages plumb during concrete placement. Maintain cage position
27 so rebar cages do not move vertically more than 6" and columns or footings have the
28 minimum required concrete cover shown in the plans.

29 Remove all temporary casings during concrete placement. Do not twist, move or
30 otherwise disturb temporary casings until the concrete depth inside casings is at least
31 10 ft or half the head, whichever is greater, above the bottom of casing being disturbed.
32 Define "head" as the difference between the highest piezometric head along the drilled
33 pier length and the static water elevation inside the excavation.

34 When removing temporary casings, maintain the required concrete depth above the
35 bottom of casing being removed except when the concrete level is at or above top of
36 piers. Sustain sufficient concrete depths to overcome pressures imposed by earth,
37 backfill and fluids. As temporary casings are withdrawn, ensure fluids trapped behind
38 casings is displaced upward and discharged out of excavations without contaminating or
39 displacing concrete.

40 Pour concrete in excavations to form uniform jointless monolithic drilled piers. Do not
41 trap soil, air, fluids or other contaminants in concrete. Remove contaminated concrete
42 from top of piers at time of concrete placement.

43 Inform the Engineer of the volume of concrete placed for each pier. For piers constructed
44 with slurry or as directed, record a graphical plot of depth versus theoretical and actual
45 concrete volumes.

46 Dry or wet placement of concrete is at the Contractor's option for piers constructed with
47 only casings if the water inflow rate into excavations is less than 6" per half hour after
48 removing any pumps from holes. Wet placement of concrete is required for all other
49 drilled pier construction.

1 (1) Dry Placement

2 If holes are filling with water for dry placement of concrete, dewater excavations as
3 much as possible before placing concrete. For drilled piers less than 80 ft long, pour
4 concrete down the center of excavations so concrete does not hit reinforcing steel or
5 excavation sidewalls. For piers longer than 80 ft, place concrete with a tremie or
6 pump pipe down the center of excavations so length of free fall is less than 80 ft.

7 (2) Wet Placement

8 For wet placement of concrete, maintain static water or slurry levels in holes before
9 placing concrete. Place concrete through steel tremies or pump pipes. Use tremies
10 with watertight joints and a diameter of at least 10". Pump concrete in accordance
11 with Article 420-5. Use approved devices to prevent contaminating concrete when
12 tremies or pump pipes are initially placed in excavations. Extend tremies or pump
13 pipes into concrete at least 5 ft at all times except when the concrete is initially
14 placed.

15 When the concrete level reaches the static water elevation inside the excavation, dry
16 placement of concrete is permitted. Before changing to dry placement, pump water
17 or slurry out of holes and remove contaminated concrete from the exposed concrete
18 surface.

19 **411-5 INTEGRITY TESTING**

20 Define "integrity testing" as crosshole sonic logging (CSL) and pile integrity testing (PIT).
21 Integrity testing may be required as noted in the plans or by the Engineer. The Engineer will
22 determine how many and which drilled piers require integrity testing. Do not test piers until
23 Drilled Pier concrete cures for at least 7 days and attains a compressive strength of at
24 least 3,000 psi.

25 **(A) Crosshole Sonic Logging**

26 If CSL testing is required, use a prequalified CSL Consultant to perform CSL testing and
27 provide CSL reports. Use a CSL Operator approved as a Field Engineer (key person) for
28 the CSL Consultant. Provide CSL reports sealed by an engineer approved as a Project
29 Engineer (key person) for the same CSL Consultant.

30 (1) CSL Testing

31 Perform CSL testing in accordance with ASTM D6760. If probes for CSL testing
32 will not pass through to the bottom of CSL tubes, the Engineer may require coring to
33 replace inaccessible tubes. Do not begin coring until core hole size and locations are
34 approved. Core at least 1.5" diameter holes the full length of piers. Upon
35 completion of coring, fill holes with clean water and cover to keep out debris.
36 Perform CSL testing in core holes instead of inaccessible tubes.

37 For piers with 4 or 5 CSL tubes, test all tube pairs. For piers with 6 or more
38 CSL tubes, test all adjacent tube pairs around spiral reinforcing steel and at least 50%
39 of remaining tube pairs selected by the Engineer. Record CSL data at depth intervals
40 of 2.5" or less from the bottom of CSL tubes to top of piers.

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- 1 (2) CSL Reports
- 2 Submit 2 copies of each CSL report within 7 days of completing CSL testing.
- 3 Include the following in CSL reports:
- 4 (a) Title Sheet
 - 5 (i) Department's TIP number and WBS element number
 - 6 (ii) Project description
 - 7 (iii) County
 - 8 (iv) Bridge station number
 - 9 (v) Pier location
 - 10 (vi) Personnel
 - 11 (vii) Report date
- 12 (b) Introduction
- 13 (c) Site and Subsurface Conditions (including water table elevation)
- 14 (d) Pier Details
 - 15 (i) Pier and casing diameters, lengths and elevations
 - 16 (ii) Drilled Pier concrete compressive strength
 - 17 (iii) Installation methods including use of casings, slurry, pumps, tremies, dry or
 - 18 wet placement of concrete, etc.
- 19 (e) CSL Results
 - 20 (i) Logs with plots of signal arrival times and energy vs. depth for all tube pairs
 - 21 tested
- 22 (f) Summary/Conclusions
 - 23 (i) Table of velocity reductions with corresponding locations (tube pair and
 - 24 depth) for all tube pairs tested
 - 25 (ii) List of suspected anomalies with corresponding locations (tube pair(s) and
 - 26 depth range)
- 27 (g) Attachments
 - 28 (i) Boring log(s)
 - 29 (ii) Field inspection forms and concrete curves (from Engineer)
 - 30 (iii) CSL tube locations, elevations, lengths and identifications
 - 31 (iv) CSL hardware model and software version information
 - 32 (v) PDF copy of all CSL data

33 (B) Pile Integrity Testing

34 If required, the Engineer will perform PIT. Provide access to and prepare top of piers for
35 PIT as directed. See [ASTM D5882](#) for PIT details.

36 (C) Further Investigation

37 Define "further investigation" as any additional testing, excavation or coring following
38 initial integrity testing. Based on concrete placement and initial integrity testing results,
39 the Engineer will determine if drilled piers are questionable and require further
40 investigation within 7 days of receiving CSL reports or completing PIT. For initial CSL
41 testing, the Engineer will typically determine whether further investigation is required
42 based on Table 411-4.

TABLE 411-4 DRILLED PIER FURTHER INVESTIGATION CRITERIA (For Initial CSL Testing)	
Velocity Reductions	Further Investigation Required?
< 20%	No
20 - 30%	As Determined by the Engineer
> 30%	Yes

1 If further investigation is necessary, the Engineer will typically require one or more of the
2 following methods to investigate questionable piers.

3 (1) CSL Testing

4 If required, use CSL testing as described above to retest questionable piers and as
5 directed, perform testing with probes vertically offset in CSL tubes. CSL offset data
6 will typically be required for all locations (tube pair and depth) with velocity
7 reductions greater than 30% and at other locations as directed. Record offset data at
8 depths, intervals and angles needed to completely delineate anomalies.

9 Provide CSL reports that meet Subarticle 411-5(A)(2). When CSL offset data is
10 required, perform tomographic analysis and provide 3 dimensional color coded
11 tomographic images of piers showing locations and sizes of anomalies.

12 (2) Excavation

13 If required, excavate around questionable piers and remove permanent casing as
14 needed to expose Drilled Pier concrete. Do not damage piers when excavating or
15 removing casings. The Engineer will determine the portions of piers to expose.

16 (3) Coring

17 If required, core questionable piers and provide PQ size cores that meet
18 ASTM D2113. The Engineer will determine the number, location and depth of core
19 holes required. Handle, log and store concrete cores in accordance with
20 ASTM D5079. Provide cores to the Engineer for evaluation and testing. Sign, date
21 and submit core logs upon completion of each core hole.

22 **(D) Defective Piers**

23 For questionable piers that are exposed or cored, the Engineer will determine if piers are
24 defective based on the results of excavation or coring. For questionable piers that are not
25 exposed or cored, the Engineer will determine if piers are defective based on the results
26 of integrity testing. Questionable piers with only CSL testing will be considered
27 defective if any velocity reductions between any tube pairs are greater than 30%.

28 **411-6 DRILLED PIER ACCEPTANCE**

29 Drilled pier acceptance is based in part on the following criteria:

30 **(A)** Temporary casings and drilling tools are removed from the drilled pier excavation or the
31 Engineer determines that a temporary casing may remain in the excavation.

32 **(B)** Drilled Pier concrete is properly placed and does not have any evidence of segregation,
33 intrusions, contamination, structural damage or inadequate consolidation
34 (honeycombing).

35 **(C)** Center of pier is within 3" of plan location and 2% of plumb. Top of pier is within
36 1" above and 3" below the elevation shown in the plans or approved by the Engineer.

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1 (D) Rebar cage is properly placed and top and center of cage is within tolerances for center of
2 pier. Tip of permanent casing does not extend below the elevation noted in the plans or
3 approved by the Engineer.

4 (E) Drilled pier is not defective or the Engineer determines the defective pier is satisfactory.
5 A pier will be considered defective based on Subarticle 411-5(D).

6 Do not grout CSL tubes or core holes, backfill around a pier or perform any work on a drilled
7 pier until the Engineer accepts the pier. If the drilled pier is accepted, dewater and grout
8 CSL tubes and core holes, and backfill around the pier with approved material to finished
9 grade. If the Engineer determines a pier is unacceptable, remediation is required.
10 Remediation may include, but is not limited to grouting, removing part or all of unacceptable
11 piers, modifying pier designs or providing replacement or additional piers or piles. Submit
12 working drawings and design calculations for acceptance in accordance with Article 105-2.
13 Ensure remediation submittals are designed, detailed and sealed by an engineer licensed by
14 the State of North Carolina. Do not begin remediation work until remediation plans are
15 approved. When repairing unacceptable piers, perform post repair testing to gauge success of
16 the repair. No extension of completion date or time will be allowed for remediation of
17 unacceptable drilled piers or post repair testing.

18 411-7 MEASUREMENT AND PAYMENT

19 ____ Dia. Drilled Piers in Soil, ____ Dia. Drilled Piers Not in Soil and ____ Dia. Drill Piers
20 will be measured and paid in linear feet. Acceptable drilled piers will be measured as the
21 difference between the specified top of pier and pier tip elevations or revised elevations
22 approved by the Engineer.

23 For bents with a not in soil pay item shown in the plans, drilled piers will be paid as ____ Dia.
24 Drilled Piers in Soil and ____ Dia. Drilled Piers Not in Soil. Define "not in soil" as material
25 with a rock auger penetration rate of less than 2" per 5 minutes of drilling at full crowd force.
26 When not in soil is encountered, seams, voids and weathered rock less than 3 ft thick with a
27 rock auger penetration rate of greater than 2" per 5 minutes of drilling at full crowd force will
28 be paid at the contract unit price for ____ Dia. Drilled Piers Not in Soil. Seams, voids and
29 weathered rock greater than 3 ft thick will be paid at the contract unit price for ____ Dia.
30 Drilled Piers in Soil where not in soil is no longer encountered. For bents with a not in soil
31 pay item shown in the plans, drilled piers through air or water will be paid at the contract unit
32 price for ____ Dia. Drilled Piers in Soil.

33 For bents without a not in soil pay item shown in the plans, drilled piers will be paid as
34 ____ Dia. Drill Piers. The contract unit price for ____ Dia. Drilled Piers will be full
35 compensation for drilling through any materials encountered.

36 The contract unit prices for ____ Dia. Drilled Piers in Soil, ____ Dia. Drilled Piers Not in
37 Soil and ____ Dia. Drill Piers will also be full compensation for spoils and slurry
38 containment and disposal, slurry construction including a slurry manufacturer representative
39 and overreaming and enlarging piers and any concrete removal, miscellaneous grading and
40 excavation. No additional payment will be made for excess Drilled Pier concrete due to
41 caving or sloughing holes or telescoping casings.

42 Reinforcing steel will be measured and paid in accordance with Article 425-6.

43 Permanent Steel Casing for ____ Dia. Drilled Pier will be measured and paid in linear feet.
44 Permanent casings will only be paid for when required by the Engineer or shown in the plans.
45 Permanent casings will be measured as the difference between the ground line or specified top
46 of pier elevation, whichever is higher, and the specified permanent casing tip elevation or
47 revised elevation approved by the Engineer. If a permanent casing cannot be installed to the
48 tip elevation shown in the plans, up to 3 ft of casing cut-off will be paid at the contract unit
49 price for Permanent Steel Casing for ____ Dia. Drilled Pier.

1 *SID Inspections* will be measured and paid in units of each. *SID Inspections* will be measured
 2 as one per pier. The contract unit price for *SID Inspections* will be full compensation for
 3 inspecting holes with the SID the first time. No additional payment will be made for
 4 subsequent inspections of the same hole.

5 The Contractor is responsible for any damage to the SID equipment due to the Contractor’s
 6 fault or negligence. Replace any damaged equipment at no additional cost to the Department.

7 *SPT Testing* will be measured and paid in units of each. *SPT Testing* will be measured as the
 8 number of standard penetration tests performed.

9 *CSL Testing* will be measured and paid in units of each. *CSL Testing* will be measured as one
 10 per pier. The contract unit price for *CSL Testing* will be full compensation for performing
 11 initial CSL testing and providing CSL reports. Subsequent CSL testing of and CSL reports
 12 for the same pier will be considered further investigation. No separate payment will be made
 13 for CSL tubes. CSL tubes including coring for inaccessible tubes and grouting will be
 14 incidental to the contract unit prices for drilled piers.

15 No payment will be made for stuck temporary casings that cannot be removed from drilled
 16 pier excavations or additional drilled pier length and reinforcing steel required due to
 17 temporary casings that remain in excavations. No payment will be made for PIT. No
 18 payment will be made for further investigation of defective piers. Further investigation of
 19 piers that are not defective will be paid as extra work in accordance with Article 104-7. No
 20 payment will be made for remediation of unacceptable drilled piers or post repair testing.

21 Payment will be made under:

Pay Item	Pay Unit
____ Dia. Drilled Piers in Soil	Linear Foot
____ Dia. Drilled Piers Not in Soil	Linear Foot
____ Dia. Drilled Piers	Linear Foot
Permanent Steel Casing for ____ Dia. Drilled Piers	Linear Foot
SID Inspections	Each
SPT Testing	Each
CSL Testing	Each

22 **SECTION 412**
 23 **UNCLASSIFIED STRUCTURE EXCAVATION**

24 **412-1 DESCRIPTION**

25 Excavate any material not classified as foundation excavation, box culvert excavation or
 26 channel excavation whose removal is required for the construction of bridges, retaining walls
 27 of reinforced concrete or reinforced masonry, arch culverts and box culverts without floor
 28 slabs, and which is classified as unclassified structure excavation in the plans, in accordance
 29 with the contract or as directed. Excavate, blast, brace, shore, provide sheeting and cribbing,
 30 backfill, haul and dispose of materials.

31 Do not deposit excavated materials, nor construct earth dikes or other temporary earth
 32 structures, in rivers, streams or impoundment or so near to such waters that they are carried
 33 into any river, stream or impoundment by stream flow or surface runoff.

34 Dispose of all timber, stumps and debris in accordance with Article 200-6.

35 **412-2 PRESERVATION OF CHANNEL**

36 Unless otherwise required by the contract, do not excavate in stream channels. Do not disturb
 37 the natural stream bed adjacent to the structure without permission.

38 Do not place material in a stream without approval. Remove materials placed within the
 39 stream area and leave the stream in its original condition, unless otherwise permitted.

Section 414

1 **412-3 UTILIZATION OF EXCAVATED MATERIAL**

2 Use and place suitable excavated material in accordance with Articles 410-7 and 410-8.
3 Notify the Engineer a sufficient time before beginning the excavation so measurements may
4 be taken of the undisturbed ground.

5 **412-4 MEASUREMENT AND PAYMENT**

6 The price and payment below will be full compensation for all items required to complete
7 unclassified structure excavation including, but not limited to, those items contained in
8 Article 412-1.

9 *Unclassified Structure Excavation at Station ____* will be paid at the contract lump sum price.

10 Payment will be made under:

Pay Item	Pay Unit
Unclassified Structure Excavation at Station ____	Lump Sum

11 **SECTION 414**
12 **BOX CULVERT EXCAVATION**

13 **414-1 DESCRIPTION**

14 Excavate all material necessary for the construction of box culverts with floor slabs in
15 accordance with the contract or as directed. Excavate, blast, drain and divert water, bail,
16 pump, brace, shore, provide sheeting, cribbing, cofferdams, culvert foundation conditioning,
17 subsurface drainage and drawings; backfill, haul and dispose of materials.

18 Do not deposit excavated materials, nor construct earth dikes or other temporary earth
19 structures in rivers, streams or impoundment or so near to such waters that they are carried
20 into any river, stream or impoundment by stream flow or surface runoff. As an exception to
21 the above, obtain written approval for the use of confined earth materials in cofferdams for
22 structure foundations.

23 **414-2 MATERIALS**

24 Refer to Division 10.

Item	Section
Foundation Conditioning Material	1016
Stone, No. 78M	1005
Subdrain Fine Aggregate	1044-1

25 **414-3 FOUNDATION EXCAVATION**

26 Notify the Engineer a sufficient time before beginning the excavation so measurements may
27 be taken of the undisturbed ground. Do not disturb the existing ground at the culvert site
28 without permission.

29 Where necessary for safety, slope, shore, brace or protect by cofferdams the foundation
30 openings in accordance with State and local safety standards. Perform foundation excavation
31 and related work in such sequence that no portion of the culvert will be endangered by
32 subsequent operations. Protect completed portions of a culvert from blasting.

33 Remove and dispose of boulders, vegetative matter and any other objectionable material.

34 Notify the Engineer after excavating each foundation. Do not place any concrete until
35 obtaining approval of the excavation depth, the character of the foundation material and
36 permission to proceed.

37 Take special care not to disturb the bottom of the excavation until immediately before placing
38 reinforcing steel and concrete.

1 414-4 CONDITIONING CULVERT FOUNDATION

2 Excavate to a depth as directed below the bottom of the barrel or wing footing and replace the
3 excavated material with foundation conditioning material.

4 When the foundation material beneath a portion of the barrel or wing footing is rock or
5 incompressible material and softer material is beneath the remainder of the barrel or wing
6 footing, excavate the rock material within the neat lines of the barrel or footing to a depth of
7 12" below the bottom of the barrel and footings and backfill with foundation conditioning
8 material.

9 Use Class VI select material foundation conditioning material in accordance with
10 Section 1016.

11 414-5 PUMPING

12 Pump from the interior of any foundation enclosure to preclude the possibility of the
13 movement of water over or through any fresh concrete. Do not pump while placing concrete
14 or for at least 24 hours thereafter, unless done from a suitable sump separated from the
15 concrete work by a substantially watertight wall.

16 414-6 UTILIZATION OF EXCAVATED MATERIAL

17 Use suitable excavated material in accordance with Article 410-7.

18 414-7 BACKFILLING AND FILLING

19 As soon as practical after completing the box culvert, place the backfill and redirect the
20 stream through the culvert.

21 Use approved material for backfill that is free from large or frozen lumps, wood or other
22 undesirable material. Where there is not an adequate quantity of suitable backfill material
23 available from culvert excavation, provide suitable backfill material compensated in
24 accordance with Subarticle 410-10(C).

25 Eliminate any excavated slope adjacent to backfill areas by stepping or serrating to prevent
26 wedge action.

27 Place and compact all portions of the backfill that become a part of roadway typical sections
28 or their foundations in accordance with Subarticles 235-3(B) and 235-3(C). Place all other
29 portions of the backfill in layers not more than 10" in depth of loose measure and compact to
30 a density comparable to the adjacent undisturbed material. Refill all excavated spaces not
31 filled with permanent work with earth up to the ground surface existing before the excavation.

32 Do not place backfill or embankment behind the walls of culverts until after placing the top
33 slab and allowing development of the minimum compressive strength required by
34 Article 420-20.

35 Place backfill or embankment material simultaneously insofar as possible to approximately
36 the same elevation on both sides of the culvert and do not carry it to an elevation higher than
37 one foot above the top of footing or bottom slab until the concrete develops the minimum
38 required strength for the class of concrete used as specified in Table 1000-1.

39 414-8 SUBSURFACE DRAINAGE AT WEEP HOLES

40 Place a stone drain consisting of one cubic foot of No. 78M stone contained in a bag of porous
41 fabric at each weep hole. Place subdrain fine aggregate beneath, around and over the stone
42 drain, so the stone drain is covered by a layer of subdrain fine aggregate at least one foot
43 thick. Connect all drains with a horizontal drain of subdrain fine aggregate at least one foot
44 square in cross section. In the case of abutments and retaining walls, in addition to the above
45 requirements, place a vertical drain of subdrain fine aggregate at least one foot square in cross
46 section at each weep hole to an elevation 2 ft below the subgrade or surface of the
47 embankment.

Section 416

1 When embankment placement around the structure is part of another contract, the portion of
2 the subsurface drainage system described above, which is located in such embankment, is not
3 part of the work of this section.

4 **414-9 MEASUREMENT AND PAYMENT**

5 The prices and payments below will be full compensation for all items required to complete
6 box culvert excavation including, but not limited to, those items in Article 414-1.

7 *Foundation Conditioning Material, Box Culvert* will be measured and paid in tons of material
8 that is placed within the established limits. The number of tons of material is determined by
9 weighing the material in trucks in accordance with Article 106-7. No deduction will be made
10 for any moisture contained in the material at the time of weighing. Such price and payment
11 will be full compensation for all excavation made below the bottom of the barrel and wing
12 footings in addition to furnishing, hauling and placing the foundation conditioning material.

13 *Culvert Excavation, Sta. ____* will be paid at the contract lump sum price. No measurement
14 for payment will be made for this pay item, and no adjustment in the contract lump sum price
15 will be made unless the size, length, elevation or location of the culvert is revised. If the size,
16 length, elevation or location of the culvert is revised, such revision will be an alteration of
17 plans or details of construction in accordance with Article 104-3.

18 Where it is necessary to provide backfill material from sources other than excavated areas or
19 borrow sources used in connection with other work in the contract, payment for furnishing
20 and hauling such backfill material will be paid as extra work in accordance with
21 Article 104-7. Placing and compacting such backfill material is not extra work but is
22 incidental to the work being performed.

23 Payment will be made under:

Pay Item	Pay Unit
Culvert Excavation, Sta. ____	Lump Sum
Foundation Conditioning Material, Box Culvert	Ton

24 **SECTION 416**
25 **CHANNEL EXCAVATION**

26 **416-1 DESCRIPTION**

27 Excavate any material outside of the pay limits of foundation excavation, unclassified
28 structure excavation or box culvert excavation, which is classified as channel excavation in
29 the plans. Place suitable excavated material as directed, drain and divert water, pump, blast,
30 haul, dispose of materials and backfill.

31 Do not deposit excavated materials, nor construct earth dikes or other temporary earth
32 structures in rivers, streams or impoundment or so near to such waters that they are carried
33 into any river, stream or impoundment by stream flow or surface runoff.

34 **416-2 CONSTRUCTION METHODS**

35 Notify the Engineer a sufficient time before beginning the excavation so measurements may
36 be taken of the undisturbed ground. Do not disturb the existing ground without permission.

37 Remove and dispose of boulders, vegetative material and any other objectionable material.

38 Use and place suitable excavated material in accordance with Articles 410-7 and 410-8.

39 **416-3 MEASUREMENT AND PAYMENT**

40 Channel excavation will be measured and paid on a cubic yard basis. Materials will measured
41 in their original position within the limits described below and computed by the average end
42 area method, that are acceptably excavated in accordance with the contract or as directed.

- 1 The upper limits for measurement are the actual ground surface at the time of starting work.
 2 The lower limits for measurement are established by the plans or as directed in writing.
 3 No measurement is made of the following excavation:
 4 (A) Mud, muck or similar semi-solid material which can be drained away or pumped without
 5 the use of a jet or nozzle.
 6 (B) Excavation before the Engineer makes measurements of the undisturbed ground.
 7 (C) Excavation that is within the pay limits of other excavation.
 8 (D) Excavation that is outside of the limits shown in the plans or as directed in writing.
 9 Where the item *Channel Excavation* is not included in the contract, no measurement or
 10 payment is made of any channel excavation, as payment at the contract unit or lump sum price
 11 for the various items in the contract will be full compensation for the work covered by this
 12 section.
 13 This price and payment will be full compensation for all items required to complete channel
 14 excavation.
 15 Payment will be made under:

Pay Item	Pay Unit
Channel Excavation	Cubic Yard

16 **SECTION 420**
 17 **CONCRETE STRUCTURES**

18 **420-1 DESCRIPTION**

19 Construct cast-in-place concrete structures and the cast-in-place concrete portions of
 20 composite structures in conformity with the lines, grades and dimensions shown in the
 21 contract. Furnish and place concrete, joint filler and sealer, curing agents, epoxy protective
 22 coating, deck drains, expansion anchors and any other material; erect and remove all
 23 falsework and forms; protect concrete in wind, rain, low humidity, high temperatures or other
 24 unfavorable weather; construct joints and weep holes; finish and cure concrete; protect
 25 concrete from rust stains; and groove bridge floors. For reinforced concrete deck slabs, in
 26 addition to the above, furnish and place reinforcing steel and bridge scuppers; and design,
 27 furnish, erect and remove all bridge deck forms including any appurtenances required by the
 28 Engineer to stabilize exterior girders during overhang construction.

29 **420-2 MATERIALS**

30 Refer to Division 10.

Item	Section
Calcium Nitrite Corrosion Inhibitor	1000-4(K)
Curing Agents	1026
Deck Drains	1054-1
Epoxy Protective Coating	1081
Expansion Anchors	1074-2
Joint Fillers	1028-1
Joint Sealers	1028
Metal Stay-in-Place Forms	1074-12
Portland Cement Concrete	1000
Reinforcing Steel	1070

Section 420

1 420-3 FALSEWORK AND FORMS

2 (A) General

3 Submit 8 sets of detailed drawings for falsework or forms for bridge superstructure and
4 other components as required by the contract for review, comments and acceptance
5 before beginning construction of the falsework or forms. This review does not relieve the
6 Contractor of full responsibility for the safety, alignment, quality or finish of the work.

7 Design falsework and forms to carry the full loads upon them, including a dead load of
8 150 lb/cf for concrete, loads caused by equipment and personnel, and for lateral pressures
9 resulting from rate of pours, setting times and effects of vibration on the concrete, so the
10 finished concrete surface conforms to the proper dimensions and contours and has
11 an even appearance.

12 Use lumber and other material for forms and falsework that is sound and in good
13 condition.

14 Set falsework and forms to give the correct elevation shown on the drawings making
15 proper allowance for shrinkage, deflections and settlement, and maintain true to lines and
16 grades designated until the concrete sufficiently hardens.

17 Where falsework or forms appear to be unsatisfactorily built in any respect either before
18 or during placing of concrete, the Engineer will order the work stopped until the defects
19 are acceptably corrected.

20 Keep the falsework and forms in place after placing of concrete for the periods specified
21 in Article 420-16. Remove falsework and forms in an acceptable manner. Do not leave
22 forms or falsework permanently in place without written approval.

23 Provide a means, satisfactory to the Engineer, to check any settlement or deflection that
24 may occur during the placing of concrete in the various portions of the work.

25 (B) Falsework

26 Build falsework on foundations of sufficient strength to carry the applied loads without
27 appreciable settlement. Support falsework that cannot be founded on solid footings on
28 ample falsework piling.

29 Use an acceptable method to compensate for shrinkage, deflection and settlement. Use
30 jacks to readily effect adjustment, if necessary, before or during placing of concrete, if
31 required by the Engineer.

32 (C) Forms

33 (1) General

34 Use forms made of wood or steel except where other materials are specified by the
35 contract or accepted by the Engineer.

36 (2) Wood Forms

37 Build forms mortar-tight of material sufficient in strength with ample studding,
38 walling and bracing to effectively prevent any appreciable horizontal and vertical
39 deflection.

40 Provide forms with interior dimensions such that the finished concrete is of the form
41 and dimensions shown in the plans.

42 Line forms, except for surfaces permanently in contact with earth fill, with plywood
43 or other approved material. Provide a lining with a smooth and uniform texture and
44 of such thickness and rigidity that a concrete surface of uniform texture and even
45 appearance results. Provide joints between form liners that are mortar tight and even
46 and maintain to prevent the opening of joints due to the shrinkage of the lumber.

1 Fillet forms at all sharp corners unless otherwise noted in the plans. Mill wood
2 chamfer strips from straight grained lumber and surface on all sides.

3 Give forms for all projections a bevel or draft to insure easy removal.

4 At all times, maintain the shape, strength, rigidity, watertightness and surface
5 smoothness of reused forms. Resize any warped or bulged lumber before reusing.
6 Do not reuse any forms that are unsatisfactory in any respect. Do not use plywood
7 sheets showing torn grain, worn edges, patches, holes from previous use or other
8 defects that impair the texture of concrete surfaces exposed to view.

9 Maintain an acceptable alignment and no broken edges on all chamfer strips.

10 Thoroughly clean forms previously used of all dirt, mortar and foreign material
11 before reusing. Before placing concrete in forms to be removed, thoroughly coat all
12 inside surfaces of the forms with commercial quality form oil or other equivalent
13 coating which permits the ready release of the forms and does not discolor the
14 concrete.

15 Construct or install metal spacers or anchorages, required within the forms for their
16 support or to hold them in correct alignment and location, in such a way that the
17 metal work can be removed to a depth of at least 1" from the exposed surface of the
18 concrete without injury to such surface by spalling or otherwise. Limit the diameter
19 to not greater than 1.5 times its depth for the recess formed in the concrete. Cut back
20 all such metal devices in exposed surfaces, upon removal of the forms, to a depth of
21 at least 1" from the face of the concrete. Carefully fill cavities produced by the
22 removal of metal devices with cement mortar of the same mix used in the body of
23 the work immediately upon removal of the forms, and leave the surface smooth, even
24 and as nearly uniform in color as possible. As an option, break off flush with the
25 concrete surface those metal devices with cross-sectional area not exceeding
26 0.05 sq.in. on surfaces permanently in contact with earth fill.

27 Do not weld metal devices to either reinforcing steel or structural steel that is
28 a permanent part of the structure without written approval.

29 (3) Steel Forms

30 Apply Subarticle 420-3(C)(2) in regards to design, mortar tightness, filleted corners,
31 beveled projections, bracing, alignment, texture and evenness of appearance of the
32 resulting concrete surface, removal, re-use and oiling to steel forms. Use steel for
33 forms of such thickness that the forms remain true to shape. Counter-sink bolt and
34 rivet heads. Design clamps, pins or other connecting devices to hold the forms
35 rigidly together and allow removal without injury to the concrete. Do not use steel
36 forms that do not present a smooth surface or line up properly. Exercise care to keep
37 steel forms free from rust, grease or other foreign matter that will tend to discolor the
38 concrete.

39 (D) Forms for Concrete Bridge Decks

40 In addition to Subarticles 420-3(C)(1) through 420-3(C)(3), the following requirements
41 apply to falsework and forms used to construct reinforced concrete bridge decks on
42 girders. Furnish all materials, labor, equipment and incidentals necessary for the proper
43 installation of falsework and forms for concrete bridge deck slabs.

44 For prestressed girder spans, the plans for the concrete deck slab are detailed for the use
45 of a cast in place slab using either precast prestressed concrete panels or fabricated metal
46 stay in place forms. Optionally, construct a cast in place slab using removable forms.

47 For structural steel spans, plans for the concrete deck slab are detailed for the use of
48 metal stay in place forms. Optionally, construct a cast in place slab using removable
49 forms. Do not use precast prestressed concrete panels on structural steel spans.

Section 420

1 If using a form system other than that detailed in the plans, do so at no additional cost to
2 the Department. Changes in slab design to accommodate the use of optional forms are
3 the responsibility of the Contractor. Submit these changes for review and approval.
4 Before using optional forms, submit 2 sets of prints of detailed checked plans of the
5 system and checked design calculations for the composite slab complying to the latest
6 *AASHTO LRFD Bridge Construction Specifications*, *AASHTO LRFD Bridge Design*
7 *Specifications* and *Highway Design Branch Structure Design Manual*. After the
8 drawings are reviewed and, if necessary, the corrections made, submit reproducible
9 drawings of the deck system to become the revised plans. Ensure that the size of the
10 sheets used for the drawings is 22" x 34". Ensure that the plans and design calculations
11 are checked and sealed by an engineer licensed by the State of North Carolina.

12 Where reinforced concrete deck slab with sand lightweight concrete is required by the
13 contract, do not use precast prestressed concrete panels.

14 Unless otherwise shown in the plans, use the same forming system for all of the same
15 type superstructure spans within the bridge. Construct the slab overhang from the
16 exterior girder to the outside edge of superstructure using removable forms.

17 (1) Precast Prestressed Concrete Panels

18 Prestressed concrete panels are subject to the requirements for prestressed concrete
19 members as specified in Section 1078, the plans and the *Standard Specifications*.

20 Design prestressed panels subject to review by the Engineer. Before using
21 prestressed panels, submit 7 sets, including one reproducible set, of detailed plans of
22 the panels for review. Submit with the checked plans one set of checked design
23 calculations for the panels complying with the latest *AASHTO LRFD Bridge Design*
24 *Specifications*, requirements detailed herein and the plans. Ensure the plans and
25 design calculations are checked and sealed by an engineer licensed by the State of
26 North Carolina. If corrections to the drawings are necessary, submit one set of
27 corrected reproducible drawings. Use a plan sheet size of 22" x 34". The drawings
28 become part of the plans.

29 Design the prestressed concrete panels in accordance with the following criteria:

30 (a) Design details to provide a mating surface joint or a draft not exceeding 1/8"
31 resulting in a joint that is closed at the top and no more than 1/4" open at bottom
32 of panel. Detail the joints filled with grout or other methods approved by the
33 Engineer to prevent leakage of the concrete. Place a chamfer or fillet, with
34 a 3/4" horizontal width, along the top edges of the panel parallel with the
35 prestressed girder.

36 (b) Design panels to support the dead load of the panel, reinforcement, plastic
37 concrete and a 50 lb/sf construction load. Design the panel and slab acting
38 compositely to support design live loads and dead loads acting on the composite
39 section. Include in the design dead load acting on the composite section
40 an additional load of 30 lb/sf for a future asphalt wearing surface. For bridges
41 up to 44 ft in width distribute equally to all deck panels superimposed dead
42 loads for such permanent bridge items as barrier rails, medians or any dead load
43 which is applied after the deck is cast. In the case of bridges over 44 ft wide,
44 distribute these loads equally to the first 2 1/2 panels adjacent to each side of the
45 load.

46 (c) The design span of the prestressed concrete panel is the clear distance between
47 edges of girders plus 2" measured parallel to the panel edges.

48 (d) Limit tension in the precompressed tensile zone to 424 psi unless the plans
49 require 0 psi tension.

(2) Fabricated Metal Stay-In-Place Forms

Furnish metal stay-in-place forms with closed tapered ends to form the concrete deck slabs as shown in the plans. Submit 8 copies of complete fabrication and erection drawings for review, comments and acceptance. Indicate on these plans the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets and a clear indication of locations of form supports. Do not fabricate the forming material until drawings are accepted.

When required by the design plans, detail stay-in-place forms with excluder plates to exclude concrete from the valleys in the forms. Foam insulation void fillers may be used in stay-in-place metal forms. Adhesive shall be used on all 3 contacting sides of the foam insulation void fillers rather than on the bottom only. The adhesive shall be compatible with the foam insulation material to not cause decomposition. Duct tape shall not be used to hold the foam insulation in place. Foam insulation shall be placed in one piece across each bay and be trimmed to not extend over the girder. Foam insulation damaged during placement of reinforcing steel shall be replaced.

Design metal stay-in-place forms in accordance with the following criteria:

- (a) Accommodate the dead load of the form, reinforcement and the plastic concrete, including the additional weight of concrete due to the deflection of the metal forms, plus 50 lb/sf for construction loads. Do not allow the unit working stress in the steel sheet to exceed 72.5% of the specified minimum yield strength of the material furnished nor 36 ksi.
- (b) Limit the horizontal leg of the support angle to 3". Design the support angle as a cantilever.
- (c) Limit the deflection under the weight of the forms, the plastic concrete and reinforcement to 1/180 of the form span or 1/2" whichever is less. Do not design for a total loading less than 120 lb/sf.
- (d) Base the permissible form camber on the actual dead load condition. Do not use camber to compensate for deflection in excess of the foregoing limits.
- (e) The design span of the form sheets is the clear distance between edges of beam or girder flanges minus 2" measured parallel to the form flutes. Design and provide form sheets with a length at least the design span of the forms.
- (f) Compute physical design properties in accordance with requirements of the American Iron and Steel Institute *Specification for the Design of Cold-Formed Steel Structural Members* latest published edition.
- (g) Provide a minimum concrete cover of 1 1/4" clear above metal stay-in-place form to the bottom mat of reinforcement.
- (h) Maintain the plan dimensions of both layers of primary deck reinforcement from the top of the concrete deck.
- (i) Do not weld to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.
- (j) Weld metal stay-in-place forms for prestressed concrete girders to embedded clips in the girder flanges. The embedded clips shall be at least 2" x 3" and 2" long. The clips shall be galvanized, 12 gauge ASTM A653 steel and have a 3/4" or 1" diameter hole in the 2" leg. The spacing of the clips shall be 12". All submitted metal stay-in-place form designs shall be able to use the standard size and spacing of the clip described above.

Section 420

1 Do not unload or handle fabricated metal stay-in-place forming materials so as to
2 damage or alter the configuration of the forms. Replace damaged materials at no
3 additional cost to the Department.

4 Store fabricated metal stay-in-place forms that are stored at the project site at least
5 4" above the ground on platforms, skids or other suitable supports and protect against
6 corrosion and damage from any source.

7 Install all forms in accordance with detailed fabrication plans submitted to the
8 Engineer for review. Clearly indicate on the fabrication plans the locations where
9 the forms are supported by steel beam flanges subject to tensile stresses. Do not
10 weld to the flanges within these locations. Do not allow form sheets to rest directly
11 on the top of the beam or girder. Securely fasten sheets to form supports with
12 a minimum bearing length of 1" at each end. Center sheets between the form
13 supports. Place form supports in direct contact with the flange of girder or beam.
14 Make all attachments by permissible welds, bolts, clips or other approved means.
15 Weld in accordance with Article 1072-18 except 1/8" fillet welds are permitted.

16 In the areas where the form sheets lap, securely fasten the form sheets to one another
17 by screws at a maximum spacing of 18". Securely attach the ends of the form sheets
18 to support angles with screws at a maximum spacing of 18".

19 Where the galvanized coating is damaged, repair in accordance with Article 1076-7.
20 Minor heat discoloration in areas of welds is not damage and does not require the
21 above repair.

22 Locate transverse construction joints at the bottom of a flute and field drill 1/4" weep
23 holes at not more than 12" on center along the line of the joint.

24 Use a saw for all cuts. Do not flame cut forms.

25 **(E) Falsework and Forms Over or Adjacent to Traffic**

26 In addition to the applicable sections in Subarticle 420-3(A) through 420-3(D), the
27 following requirements apply to falsework and forms including metal stay-in-place forms
28 and precast concrete deck panels erected over vehicular, pedestrian or railroad traffic or
29 vessel traffic on navigable waterways. It also covers falsework and forms for those parts
30 of a substructure unit constructed within 20 ft of the edge of a travelway or railroad track
31 and more than 25 ft above the ground line at the time of substructure construction.

32 (1) Submittals

33 Submit detailed drawings as required by the contract and one set of design
34 calculations for falsework and forms for review and acceptance before beginning
35 construction of the falsework or forms. Ensure the drawings and design calculations
36 are prepared, signed and sealed by an engineer licensed by the State of
37 North Carolina. These submittal requirements apply to all falsework and form
38 systems covered by this section.

39 (2) Design

40 Design falsework and forms for the combined effects of dead load and live load and
41 with appropriate safety factors in accordance with this section and the respective
42 design codes of the materials used. Include the weight of concrete, reinforcing steel,
43 forms and falsework in the dead load. Live load includes the actual weight of any
44 equipment the falsework supports, applied as concentrated loads at the points of
45 contact and a uniform load of at least 20 lb/sf applied over the supported area.
46 In addition, apply a line load of 75 lb/ft along the outside edge of deck overhangs.

1 (3) Inspection

2 Before the form or falsework system is loaded, inspect the erected falsework and
3 forms and submit a written statement certifying that the erected falsework system
4 complies with the accepted detailed drawings prepared by an engineer licensed by
5 the State of North Carolina. Submit a separate certification for each span, unit or
6 bridge component. Any condition that does not comply with the accepted drawings,
7 or any other condition deemed unsatisfactory by the Engineer, is cause for rejection
8 until corrections are made.

9 **420-4 PLACING CONCRETE**

10 Do not place concrete until the depth of the excavation, character of the foundation material,
11 adequacy of the forms and falsework, placement of reinforcement and other embedded items
12 are inspected and approved. Do not place concrete without the Department's inspector
13 present.

14 Place concrete in daylight or obtain approval for an adequate lighting system for construction
15 and inspection of the work.

16 In preparation for the placing of concrete, remove all sawdust, chips and other construction
17 debris and extraneous matter from the interior of forms. Remove hardened concrete and
18 foreign matter from tools, screeds and conveying equipment.

19 Ensure that the concrete temperature at the time of placement in the forms is at least 50°F and
20 no more than 95°F, except where other temperatures are required by Article 420-7
21 and 420-14.

22 Do not use concrete that does not reach its final position in the forms within the time
23 stipulated in Subarticle 1000-4(E).

24 Thoroughly clean and wet surfaces, other than foundation surfaces, immediately before
25 placing concrete to help bonding to those surfaces.

26 Regulate the placement of concrete so the pressures caused by the wet concrete do not exceed
27 those used in the design of the forms.

28 Thoroughly work the external surface of all concrete during the placing with approved tools.
29 During the placing of concrete, take care to use methods of compaction that result in a surface
30 of even texture free from voids, water or air pockets, and that force the coarse aggregate away
31 from the forms to leave a mortar surface.

32 Place concrete to avoid segregation of the materials and the displacement of the
33 reinforcement.

34 Equip chutes on steep slopes with baffle boards or provide chutes in short lengths that reverse
35 the direction of movement.

36 Use all chutes, troughs and pipes made from suitable materials other than aluminum and keep
37 them clean and free from coating of hardened concrete by thoroughly flushing with water
38 after each run. Discharge the water used for flushing clear of the structure.

39 Confine concrete dropped more than 5 ft by closed chutes or pipes, except in walls of box
40 culverts or retaining walls unless otherwise directed.

41 Take care to fill each part of the form by depositing the concrete as near to its final position as
42 possible. Work the coarse aggregate back from the forms and around the reinforcement
43 without displacing the bars. After initial set of the concrete, do not jar the forms and do not
44 place strain on the projecting reinforcement or other items embedded in the concrete.

Section 420

1 Compact all concrete required to be vibrated with approved high frequency internal vibrators
2 or other approved type of vibrators immediately after depositing concrete in the forms. In all
3 cases, have available at least 2 vibrators in good operating condition and 2 sources of power at
4 the site of any structure in which more than 25 cy of concrete is required. Do not attach or
5 hold the vibrators against the forms or the reinforcing steel. When vibrating concrete
6 containing epoxy coated reinforcing steel, use a vibrator with a protective rubber head as
7 approved by the Engineer. Vibrate with care and avoid displacement of reinforcement, ducts
8 or other embedded elements. Vibrate in the appropriate location, manner and duration to
9 secure maximum consolidation of the concrete without causing segregation of the mortar and
10 coarse aggregate and without causing water to flush to the surface. When placing concrete to
11 a depth in excess of 12" and containing one or more horizontal layers of reinforcing steel,
12 place the concrete in horizontal layers not more than 12" thick. Place and compact each layer
13 before the preceding layer takes initial set such that there is no surface of separation between
14 layers. Do not taper layers of concrete in wedge-shaped slopes but instead place them with
15 reasonably square ends and level tops.

16 If placing additional concrete against hardened concrete, take care to remove all laitance and
17 to roughen the surfaces of the concrete to ensure that fresh concrete is deposited upon sound
18 concrete surfaces and an acceptable bond is obtained. Thoroughly wet the existing concrete
19 for at least 2 hours before placing additional concrete.

20 Deposit and compact to form a compact, dense, impervious concrete of uniform texture which
21 shows smooth faces on exposed surfaces. Repair, remove and replace in whole or in part as
22 directed and at no additional cost to the Department, any section of concrete found to be
23 porous, cracked, plastered or otherwise defective.

24 Protect beams and girders during concreting operations. Remove any concrete that gets on
25 beams or girders immediately by an approved method to restore the surface to the specified
26 condition.

27 **420-5 PUMPING CONCRETE**

28 Placement of concrete by pumping is permitted only when approved. Use and locate suitable
29 pumping equipment that is adequate in capacity for the work and so no vibrations result which
30 might damage freshly placed concrete. Do not use pumping equipment, including the conduit
31 system, which contains any aluminum or aluminum alloy that comes in contact with the
32 concrete.

33 Waste all grout used to lubricate the inner surfaces of the conduit system.

34 Pump so a continuous stream of concrete without air pockets is delivered. For test purposes,
35 take concrete from the discharge end of the pump.

36 **420-6 SLUMP TESTS**

37 The slump of the concrete is determined in accordance with AASHTO T 119.

38 When a slump test is made and the results of the test exceed the specified maximum, a check
39 test is made immediately from the same batch or truck load of concrete. If the average of the
40 2 test results exceeds the specified maximum slump, the batch or truck load that contains the
41 batch is rejected.

42 **420-7 PLACING CONCRETE IN COLD WEATHER**

43 **(A) General**

44 Do not place concrete when the air temperature, measured at the location of the
45 concreting operation in the shade away from artificial heat, is below 35°F without
46 permission. When such permission is granted, uniformly heat the aggregates and water
47 to a temperature not higher than 150°F. Place the concrete when the temperature of the
48 heated concrete is at least 55°F and not more than 80°F.

1 Use aggregates that are free of ice, frost and frozen particles. Do not place concrete on
2 frozen foundation material.

3 Protect all concrete with heated enclosures or by insulation whenever any of the
4 following conditions occur:

5 (1) The concrete is placed when the air temperature, measured at the location of the
6 concreting operation in the shade away from artificial heat, is below 35°F.

7 (2) The air temperature, measured at the location of the freshly placed concrete in the
8 shade away from artificial heat, is below 35°F and the concrete has not yet attained
9 an age of 72 hours or an age of 48 hours when using high early strength Portland
10 cement concrete. If the mix contains fly ash or ground granulated blast furnace slag,
11 protect the concrete for 7 days.

12 Provide and place, at directed locations, a sufficient number of maximum-minimum
13 recording thermometers to provide an accurate record of the temperature surrounding the
14 concrete during the entire protection period.

15 Assume all risks connected with the placing of concrete under the cold weather
16 conditions referred to herein. Permission given to place concrete when the temperature is
17 below 35°F and the subsequent protection of the concrete as required herein does not
18 relieve the Contractor in any way of the responsibility for obtaining the required results.

19 **(B) Heated Enclosures**

20 Immediately enclose Portland cement concrete that is placed when the air temperature is
21 below 35°F and Portland cement concrete that has not yet attained an age of 72 hours.
22 Enclose the cement before the air temperature falls below 35°F with a housing consisting
23 of canvas or other approved material supported by an open framework. Maintain the air
24 surrounding the concrete at a temperature of at least 50°F and no more than 90°F for the
25 remainder of the 72-hour period. Apply these same requirements to high early strength
26 Portland cement concrete except reduce the 72-hour period to 48 hours. Do not begin
27 these time periods until completing manipulation of each separate mass of concrete.

28 Provide such heating apparatus as stoves, salamanders or steam equipment and the
29 necessary fuel. When using dry heat, provide means of preventing loss of moisture from
30 the concrete.

31 **(C) Insulation**

32 As an alternate to the heated enclosure specified in Subarticle 420-7(B), use insulated
33 forms or insulation meeting all requirements of this subarticle to protect concrete. Use
34 insulation under the same conditions that require heated enclosures. Place the insulation
35 on the concrete as soon as initial set permits.

36 When using insulation for cold weather protection, batch concrete for sections 12" or less
37 in thickness or diameter as outlined below. Use Type III Portland cement without any
38 increase in cement content, or use Type I or II Portland cement with the cement content
39 increased to 1.80 barrels/cy. When the mix includes fly ash, use a mix containing
40 572 lb/cy of cement and at least 172 lb/cy of fly ash. When the mix includes ground
41 granulated blast furnace slag, use a mix containing 465 lb/cy of cement and 250 lb/cy of
42 ground granulated blast furnace slag.

43 Use insulated materials with a minimum thickness of 1". Insulate overhang forms both
44 on the outside vertical faces and on the underside with a 1" minimum thickness of either
45 rigid or blanket type insulation. Use insulating materials which provide a minimum
46 system R value of 4.0 in the up mode as determined by ASTM C1363 with a 15 mph
47 wind over the cold side of the material and a minimum differential of 50°F.
48 Furnish results of tests conducted in accordance with ASTM C1363 by
49 an acceptable commercial testing laboratory for review, comments and acceptance.

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1 Obtain such acceptance before use of the material. Face or cover insulating blankets, top
2 and bottom, with polyethylene or similar waterproofing material meeting Article 1026-3
3 except for the length and color requirements. Place blankets on the concrete to form a
4 waterproof surface for the protected concrete. Do not use blankets with rips and tears in
5 the waterproofing material unless acceptably repaired. When the anticipated low
6 temperature expected during the protection period is less than 10°F, provide 2" of
7 insulation. Overlap blanket insulation mats at the edges by at least 6". Tightly butt rigid
8 type insulation sheets together and seal. Take particular care to provide effective
9 protection of curbs, corners and around protruding reinforcing steel.

10 Should the air under the insulation fall below 50°F during the protection period,
11 immediately cover the concrete with canvas and framework or other satisfactory housing
12 and apply heat uniformly at a rate such that the air surrounding the concrete is at least
13 50°F for the remainder of the protection period.

14 If insulating materials are removed from the concrete before the expiration of the curing
15 period, cure the concrete for the remainder of the period in accordance with
16 Article 420-15.

17 **420-8 CONSTRUCTION JOINTS**

18 Provide construction joints only where located in the plans or shown in the placing schedule,
19 unless otherwise approved in writing.

20 Place the concrete in each integral part of the structure continuously. Do not start work on
21 any such part unless the concrete supply, forces and equipment are sufficient to complete the
22 part without interruption in the placing of the concrete.

23 In case of emergency, make construction joints or remove the concrete as directed.

24 Make construction joints without keys, except when required in the plans. Rough float
25 surfaces of fresh concrete at horizontal construction joints sufficiently to thoroughly
26 consolidate the concrete at the surface.

27 After placing concrete to the construction joint and before placing fresh concrete, thoroughly
28 clean the entire surface of horizontal construction joints of surface laitance, curing compound
29 and other materials foreign to the concrete. Clean vertical construction joints of curing
30 compound and other materials foreign to the concrete.

31 Thoroughly clean and wet concrete surfaces for at least 2 hours before placing additional
32 concrete to help bonding.

33 **420-9 WIDENING EXISTING STRUCTURES**

34 Where plans call for widening existing concrete structures or otherwise require bonding new
35 concrete to old, remove portions of the existing structures as indicated in the plans.

36 When extending an existing culvert, remove the following portions of the existing culvert: the
37 portions that interfere with the proposed extension, headwalls only as necessary to clear
38 proposed subgrade by at least 18" and wingwalls to square surfaces the full thickness of the
39 new sidewalls. Cut existing wingwall reinforcing steel off flush with the concrete surface.

40 Thoroughly roughen, clean of loose material and wet connecting surfaces of the old concrete
41 for at least 2 hours before placing new concrete.

42 **420-10 EXPANSION JOINTS**

43 **(A) General**

44 Locate and construct all joints as shown in the plans.

45 Chamfer or edge the edges of joints as shown in the plans or as directed.

1 Immediately after removing the forms, inspect the expansion joint carefully.
2 Neatly remove any concrete or mortar in the joint.

3 **(B) Filled Joints**

4 Use cork, bituminous fiber, neoprene or rubber in accordance with Article 1028-1 in all
5 expansion joint material. Use an optional second layer to obtain the required thickness,
6 when a thickness of more than 1" is required.

7 Cut the joint filler to the same shape and size as the area to be covered except cut it
8 1/2" below any surface that is exposed to view in the finished work. As an option, cut the
9 joint filler the same size and shape as that of the adjoining surfaces and neatly cut back
10 the material 1/2" on the surfaces that are exposed to view after the concrete hardens. Cut
11 the joint filler out of as few pieces as practical and, except as noted above, completely fill
12 the space provided. Fasten the pieces in any one joint together in an approved manner.
13 Do not use loose fitting or open joints between sections of filler or between filler and
14 forms. Do not use joints made up with small strips. Place 2-ply roofing felt over all
15 joints in the filler material in vertical expansion joints below top of curbs. Place the felt
16 on the side of the joint adjacent to the new pour.

17 In accordance with Article 1028-3, seal all expansion joints with a low modulus silicone
18 sealant.

19 **420-11 DRAINS IN WALLS AND CULVERTS**

20 Construct drain holes and weep holes in abutment walls, wing walls, retaining walls and the
21 exterior walls of culverts as shown in the plans unless otherwise directed and backfill in
22 accordance with Articles 414-7 and 414-8.

23 Cover drain holes and weep holes at the back face of the wall with hardware cloth of
24 commercial quality, approximately No. 4 wire reinforcement, of aluminum or galvanized steel
25 wire.

26 **420-12 ANCHOR BOLTS AND BEARING AREAS**

27 **(A) Anchor Bolts**

28 Accurately set all necessary anchor bolts in piers, abutments or pedestals either while
29 placing concrete, in formed holes or in holes cored or drilled after the concrete sets.

30 If set in the concrete, position the bolts with templates and rigidly hold in position while
31 placing the concrete.

32 Form holes by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves or
33 other approved devices, and withdrawing them after the concrete partially sets. Provide
34 holes formed in this manner that are at least 4" in diameter.

35 Core holes at least 1" larger in diameter than the bolt used. Use approved equipment for
36 coring concrete. Do not use impact tools. Place reinforcing steel to provide adequate
37 space to core bolt holes without cutting the reinforcing steel.

38 During freezing conditions, protect anchor bolt holes from water accumulation at all
39 times.

40 Bond the anchors with a nonshrink Portland cement grout or a grout made with epoxy
41 resin. Completely fill the holes with grout. Use any pre-approved nonshrink
42 composition compatible with the concrete.

43 **(B) Bearing Areas**

44 Finish bridge seat bearing areas to a true level plane to not vary perceptibly from
45 a straightedge placed in any direction across the area.

46 Place bearing plates in accordance with Article 440-4.

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1 420-13 ADHESIVELY ANCHORED ANCHOR BOLTS OR DOWELS

2 (A) Description

3 The work covered by this section consists of furnishing all necessary labor, equipment
4 and materials and performing all operations necessary for installing anchor bolts/dowels
5 in concrete using an adhesive bonding system in accordance with the details shown in the
6 plans and with Article 1081-2.

7 The use of adhesive anchors for overhead installments is not permitted.

8 Submit a description of the proposed adhesive bonding system to the Engineer for
9 review, comments and acceptance. Include in the description the bolt type and its
10 deformations, equipment, manufacturer's recommended hole diameter, embedment
11 depth, material specifications and any other material, equipment or procedure not covered
12 by the contract. List the properties of the adhesive, including density, minimum and
13 maximum temperature application, setting time, shelf life, pot life, shear strength and
14 compressive strength. If bars/dowels containing a corrosion protective coating are
15 required, provide an adhesive that does not contain any chemical elements that are
16 detrimental to the coating and include a statement to this effect in the submittal
17 concerning the contents as required by Federal or State laws and regulations.

18 (B) Procedure

19 (1) Drilling of Holes into Concrete

20 When directed, use a jig or fixture to ensure the holes are positioned and aligned
21 correctly during the drilling process. Upon approval, adjusting hole locations to
22 avoid reinforcing steel is permitted.

23 Drill the holes with a pneumatic drill unless another drilling method is approved.
24 Follow the manufacturer's recommendations regarding the diameter of the drilled
25 hole.

26 Immediately after completion of drilling, blow all dust and debris out of the holes
27 with oil-free compressed air using a wand extending to the bottom of the hole.
28 Remove all dust from the sides of the holes by brushing the holes with a stiff-bristled
29 brush of a sufficient size and then blow the hole free of dust. Repeat this procedure
30 until the hole is completely clean. Check each hole with a depth gauge to ensure
31 proper embedment depth.

32 Repair spalled or otherwise damaged concrete using approved methods.

33 (2) Inspection of Holes

34 Inspect each hole immediately before placing the adhesive and the anchor
35 bolts/dowels. Ensure all holes are dry and free of dust, dirt, oil and grease. Rework
36 any hole that does not meet the requirements of the contract.

37 (3) Mixing of Adhesive

38 Mix the adhesive in strict conformance with the manufacturer's instructions.

39 (4) Embedment of Anchor Bolt/Dowel

40 Clean each anchor bolt/dowel so it is free of all rust, grease, oil and other
41 contaminants.

42 Unless otherwise shown in the plans, the minimum anchor bolt/dowel embedment
43 depth is such that the adhesive develops at least 125% of the anchor bolt/dowel yield
44 load as determined by the manufacturer.

1 Installation of the adhesive anchors shall be in accordance with manufacturer's
2 recommendations and shall occur when the concrete is above 40°F and has reached
3 its 28 day strength. The anchors shall be installed before the adhesive's initial set
4 (gel time).

5 Insert the anchor bolt/dowel the specified depth into the hole and slightly agitate it to
6 ensure wetting and complete encapsulation. After insertion of the anchor bolt/dowel,
7 strike off any excessive adhesive flush with the concrete face. Should the adhesive
8 fail to fill the hole, add additional adhesive to the hole to allow a flush strike-off. Do
9 not disturb the anchor bolts/dowels while adhesive is hardening.

10 (C) Field Testing

11 When specified in the plans, test the installed anchor bolts/dowels for adequate adhesive
12 as specified below. Inform the Engineer when the tests will be performed at least 2 days
13 before testing. Conduct the tests in the presence of the Engineer.

14 Use a calibrated hydraulic centerhole jack system for testing. Place the jack on a plate
15 washer that has a hole at least 1/8" larger than the hole drilled into the concrete. Position
16 the plate washer on center to allow an unobstructed pull. Position the anchor
17 bolts/dowels and the jack on the same axis. Ensure an approved testing agency calibrates
18 the jack within 6 months before testing. Supply the Engineer with a certificate of
19 calibration.

20 In the presence of the Engineer, field test the anchor bolt or dowel in accordance with the
21 test level shown in the plans and the following:

22 (1) Level 1 Field Testing

23 Test at least 1 anchor but at least 10% of all anchors to 50% of the yield load shown
24 in the plans. If less than 60 anchors are to be installed, install and test the required
25 number of anchors before installing the remaining anchors. If more than 60 anchors
26 are to be installed, test the first 6 anchors before installing the remaining anchors,
27 then test 10% of the number in excess of 60 anchors.

28 (2) Level 2 Field Testing

29 Test at least 2 anchors but at least 10% of the all anchors to 80% of the yield load
30 shown in the plans. If less than 60 anchors are to be installed, install and test the
31 required number of anchors before installing the remaining anchors. If more than
32 60 anchors are to be installed, test the first 6 anchors before installing the remaining
33 anchors, then test 10% of the number in excess of 60 anchors.

34 Testing should begin only after the manufacturer's recommended cure time has been
35 reached. For testing, apply and hold the test load for 3 minutes. If the jack experiences
36 any drop in gauge reading, the test shall be restarted. For the anchor to be deemed
37 satisfactory, the test load shall be held for 3 minutes with no movement or drop in gauge
38 reading.

39 Record data for each anchor bolt or dowel tested on the report form entitled Installation
40 Test Report of Adhesively Anchored Anchor Bolts or Dowels. Obtain this form from the
41 Department's Materials and Tests Engineer. Submit a copy of the completed report
42 forms to the Engineer.

43 Final acceptance of the adhesively anchored system is based on the conformance of the
44 pull test. Failure to meet the criteria of this specification is grounds for rejection.

45 Remove all anchors or dowels that fail the field test without damage to the surrounding
46 concrete. Redrill holes to remove adhesive bonding material residue and clean the hole
47 in accordance with specifications. For reinstalling replacement anchors or dowels, follow
48 the same procedures as new installations. Do not reuse failed anchors or dowels unless
49 approved by the Engineer.

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1 420-14 PLACING AND FINISHING BRIDGE DECKS

2 (A) Placing Concrete

3 Unless otherwise noted in the plans, use Class AA cast-in-place concrete conforming to
4 Section 1000. When noted in the plans, use sand lightweight concrete conforming to
5 Section 1000.

6 Place concrete in accordance with these specifications. Properly vibrate concrete to
7 avoid honeycomb and voids. Ensure pouring sequences, procedures and mixes are
8 approved by the Engineer.

9 For metal stay-in-place forms, do not place concrete on the forms to a depth greater than
10 12" above the top of the forms. Do not drop concrete more than 3 ft above the top of the
11 forms, beams or girder. Keep the top surface of prestressed concrete panels clean.
12 Thoroughly inspect panels and remove any foreign matter, oil, grease or other
13 contaminants either with a high pressure water blast or sand blast. Saturate the top
14 surface of the prestressed concrete panels by thoroughly wetting the top surface with
15 water for at least 2 hours before placing the cast-in-place concrete slab. Do not allow the
16 wetted panel surface to dry and remove all puddles and ponds of water from the surface
17 of the panels and top of girder flanges before placing the cast-in-place concrete slab.

18 Obtain a smooth riding surface of uniform texture, true to the required grade and cross
19 section, on all bridge decks.

20 Do not place bridge deck concrete until the Engineer is satisfied that adequate personnel
21 and equipment are present to deliver, place, spread, finish and cure the concrete within
22 the scheduled time; that experienced finishing machine operators and concrete finishers
23 are employed to finish the deck; and that weather protective equipment and all necessary
24 finishing tools and equipment are on hand at the site of the work and in satisfactory
25 condition for use. Between April 15 and October 15, begin placing the bridge deck
26 concrete as early as practical to allow the work to be accomplished during the cooler
27 hours when forms, beams and reinforcing steel are at ambient air temperatures.

28 Unless otherwise permitted, set the rate of concrete placement and use a set retarder such
29 that the concrete remains workable until the entire operation of placing, screeding,
30 rescreeding, surface testing and corrective measures where necessary are complete. Use
31 of a set retarder is waived when conditions clearly indicate it is not needed.

32 Place concrete in the deck when the concrete temperature at the time of placement is at
33 least 50°F and no more than 90°F, except where other temperatures are required by
34 Article 420-7.

35 Place concrete at a minimum rate of 35 cy/hr.

36 Place and firmly secure supports for screeds or finishing machines before beginning
37 placement of concrete. Set supports to elevations necessary to obtain a bridge roadway
38 floor true to the required grade and cross section, and make allowance for anticipated
39 settlement. Use supports of a type that upon installation, no springing or deflection
40 occurs under the weight of the finishing equipment. Locate the supports such that
41 finishing equipment operates without interruption over the entire bridge deck.

42 Immediately before placing bridge deck concrete, check all falsework and make all
43 necessary adjustments. Provide suitable means such as telltales to permit ready
44 measurement by the Engineer of deflection as it occurs. Unless otherwise permitted, do
45 not adjust the profile grade-line for any of the forming types used.

46 On continuous steel beam or girder spans, cast the concrete in the order shown in the
47 plans. Place concrete in a continuous manner between headers. Use approved screeds,
48 screed supports and screeding methods.

(B) Finishing

Unless otherwise specified or permitted, use mechanically operated longitudinal or transverse screeds for finishing bridge deck concrete. Do not use vibratory screeds unless specifically approved. Use readily adjustable screeds with sufficient rigidity and width to strike-off the concrete surface at the required grade. Do not use aluminum strike-off elements of screeds and hand tools used for finishing concrete.

Furnish personnel and equipment necessary to verify the screed adjustment and operation before beginning concrete placement.

Unless otherwise permitted, do not use longitudinal screeds for pours greater than 85 ft in length. Place sufficient concrete ahead of the screeded area to assure all dead load deflection occurs before final screeding.

When using a transverse screed on a span with a skew angle less than 75° or more than 105°, orient and operate the truss or beam supporting the strike-off mechanism parallel to the skew. Position the strike-off parallel to the centerline of bridge and make the leading edge of concrete placement parallel to the skew. If approved, operate at a reduced skew angle on very wide or heavily skewed spans where the distance between screed supports exceeds 100 ft.

Orient and operate transverse screeds used on spans with skew angles between 75° and 105° parallel to the skew or perpendicular to the centerline of bridge. Position the strike-off parallel to the centerline of bridge. Before placing concrete, verify the adjustment and operation of the screed as directed by operating the screed over the entire area and across all end bulkheads. Check the floor thickness and cover over reinforcing steel shown in the plans and make adjustments as necessary.

During the screeding operation, keep an adequate supply of concrete ahead of the screed and maintain a slight excess immediately in front of the screed. Operate the screed to obtain a substantially uniform surface finish over the entire bridge deck. Do not allow workmen to walk on the concrete after screeding. Use at least 2 approved work bridges to provide adequate access to the work for finishing, testing, straightedging, making corrections, fogging, applying curing medium and for other operations requiring access to the bridge deck. Support the work bridges outside the limits of concrete placement.

The Engineer will take random depth checks of deck thickness and cover over reinforcing steel over the entire placement area and directly behind the screed in the fresh concrete. If depth checks indicate variations from plan dimensions in excess of 1/2", take corrective action immediately.

Immediately following the screed and while the concrete is still workable, test the floor surface for irregularities with a 10 ft straightedge. Test by holding the straightedge in successive positions parallel to the centerline of bridge and in contact with the floor surface. Test the surface approximately 18" from the curb line, at the centerline of each lane and at the centerline of 2 lane bridges. Advance along the bridge in stages of not more than half the length of straightedge. Test the surface transversely at the ends, quarter points and center of the span as well as other locations as directed.

Immediately correct areas showing depressions or high spots of more than 1/8" in 10 ft by filling depressions with fresh concrete or by striking off high spots. Make corrections with hand tools or a combination of hand tools and rescreeding. Do not use the straightedge as a finishing tool. Give surfaces adjacent to expansion joints special attention to assure they meet the required smoothness.

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1 Provide on site fogging equipment which is capable of applying water to the concrete in
2 the form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation
3 of mixing water from the concrete on the bridge deck resulting from wind, high
4 temperature, low humidity or a combination of these factors. Do not apply the moisture
5 from the nozzle under pressure directly upon the concrete and do not allow it to
6 accumulate on the surface in a quantity sufficient to cause a flow or wash the surface.
7 Maintain responsibility for determining when to apply the fog mist but apply it when
8 directed.

9 Keep readily available on site an adequate supply of suitable coverings that will protect
10 the surface of the freshly placed bridge deck from rain. After the water sheen disappears
11 from the surface and before the concrete becomes non-plastic, finish the surface of the
12 floor further by burlap dragging, fine bristle brooming, belting or other acceptable
13 method which produces an acceptable uniform texture.

14 Do not use membrane curing compound unless approved. Cure the concrete using the
15 water method in accordance with Subarticle 420-15(B), with the following exceptions.
16 Before reaching initial set, place a curing medium consisting of burlap under
17 polyethylene sheets or another approved material on the deck and keep moist for at least
18 7 curing days. Wet the burlap or other approved curing medium before placing on the
19 deck. Apply water to the curing medium through soaker hoses or another approved
20 method. Apply water in amounts to keep the medium moist but do not allow the water to
21 flow or pond on the deck.

22 After curing the concrete, test the finished surface with an approved rolling straightedge
23 designed, constructed and adjusted to accurately indicate or mark all floor areas which
24 deviate from a plane surface by more than 1/8" in 10 ft. Remove all high areas in the
25 hardened surface in excess of 1/8" in 10 ft with an approved grinding or cutting machine.
26 Where variations are such that the corrections will extend below the limits of the top
27 layer of grout, seal the corrected surface with an approved sealing agent as required. If
28 approved, correct low areas in an acceptable manner. Produce corrected areas that have a
29 rough, uniform texture and present neat patterns. In all cases, maintain at least 2" of
30 concrete cover over reinforcement.

31 Unless otherwise indicated in the plans, groove bridge decks. Produce grooves
32 perpendicular to the centerline of bridge. Do not start grooving until final straightedging
33 and, when necessary, acceptable corrective measures are complete. Cut grooves into the
34 hardened concrete using a mechanical saw device, which leaves rectangular grooves
35 1/8" wide and 3/16" deep. Produce grooves that have a center to center spacing of 3/4".
36 Do not groove the deck surface within 18" of the gutter lines and 2" of expansion joints
37 or elastomeric concrete in expansion joint blockouts. On skewed bridges, ungrooved
38 triangular areas adjacent to the joint are permitted, provided the distance from the
39 centerline joint to the nearest groove, as measured parallel to the centerline of roadway,
40 does not exceed 18". Between expansion joints on horizontally curved bridges,
41 periodically adjust the grooving operation such that adjacent grooves are separated by no
42 more than 3" along the outer radius of the bridgedeck.

43 Continuously remove all slurry or other residue resulting from the grooving operation
44 from the bridge deck by vacuum pick-up or other approved methods. Prevent slurry from
45 flowing into deck drains or onto the ground or body of water under the bridge. Dispose
46 of all residue off the project.

47 (C) Inspection

48 The Engineer observes all phases of the construction of the bridge deck slab. These
49 phases include installation of the metal forms; location and fastening of the
50 reinforcement; composition of concrete items; mixing procedures, concrete placement
51 and vibration; and finishing of the bridge deck.

1 After the deck concrete is in place for a minimum period of 2 days, test the concrete for
2 soundness and bonding of the metal stay-in-place forms by sounding with a hammer as
3 directed. For at least 50% of the individual form panels, as selected by the Engineer,
4 hammer test over the entire area of the panel. If areas of doubtful soundness are
5 disclosed by this procedure, remove the forms from such areas for visual inspection after
6 the pour attains a minimum compressive strength of 2,400 psi. Remove the stay-in-place
7 forms.

8 At locations where sections of the forms are removed, do not replace the forms, but repair
9 the adjacent metal forms and supports to present a neat appearance and assure their
10 satisfactory retention. As soon as the forms are removed, allow the Engineer to examine
11 for cavities, honeycombing and other defects. If irregularities are found, and in the
12 opinion of the Engineer these irregularities do not justify rejection of the work, repair the
13 concrete as directed. If the concrete where the forms are removed is unsatisfactory,
14 remove additional forms, as necessary, to inspect and repair the slab. Modify the
15 methods of construction as required to obtain satisfactory concrete in the slabs. Remove
16 and repair all unsatisfactory concrete as directed.

17 Provide all facilities as are reasonably required for the safe and convenient conduct of the
18 Engineer's inspection procedures.

19 **420-15 CURING CONCRETE**

20 **(A) General**

21 Unless otherwise specified in the contract, use any of the following methods except for
22 membrane curing compounds on bridge deck and approach slab, or on concrete which is
23 to receive epoxy protective coating in accordance with Article 420-18. Advise the
24 Engineer before using the proposed method. Ensure all material, equipment and labor
25 necessary to promptly apply the curing are on the site before placing any concrete. Cure
26 all patches in accordance with this article. Improperly cured concrete is considered
27 defective.

28 Define "curing temperature" as the atmospheric temperature taken in the shade away
29 from artificial heat, with the exception that it is the temperature surrounding the concrete
30 where the concrete is protected in accordance with Article 420-7.

31 Define a "curing day" as any consecutive 24-hour period, beginning when the
32 manipulation of each separate mass is complete, during which the air temperature
33 adjacent to the mass does not fall below 40°F.

34 After placing the concrete, cure it for 7 full curing days.

35 Take all reasonable precautions to prevent plastic shrinkage cracking of the concrete,
36 including the provision of wind screens, fogging, application of an approved temporary
37 liquid moisture barrier or the early application of temporary wet coverings to minimize
38 moisture loss.

39 Repair, remove or replace as directed concrete containing plastic shrinkage cracks.

40 **(B) Water Method**

41 Keep the concrete continuously wet by the application of water, through soaker hoses or
42 another approved method, for a minimum period of 7 curing days after placing the
43 concrete.

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1 When using cotton mats, rugs, carpets, earth blankets or sand blankets to retain the
2 moisture, keep the entire surface of the concrete damp by applying water with a nozzle
3 that so atomizes the flow that a mist and not a spray is formed, until the surface of the
4 concrete is covered with the curing medium. Do not apply the moisture from the nozzle
5 under pressure directly upon the concrete and do not allow it to accumulate on the
6 concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of
7 the curing period, clear the concrete surfaces of all curing mediums.

8 (C) Membrane Curing Compound Method

9 Spray the entire surface of the concrete uniformly with a wax-free, resin-base curing
10 compound conforming to Article 1026-2. Use clear curing compound to which a fugitive
11 dye is added for color contrast on bridge superstructures, substructures and retaining
12 walls. Use either white pigmented or clear curing compound on culverts.

13 Apply the membrane curing compound after the surface finishing is complete and
14 immediately after the free surface moisture disappears. During the finishing period,
15 protect the concrete by applying water with the fogging equipment specified in
16 Subarticle 420-15(B).

17 Seal the surface with a single uniform coating of the specified type of curing compound
18 applied at the rate of coverage recommended by the manufacturer or as directed, but at
19 least one gallon per 150 sf of surface area.

20 At the time of use, thoroughly mix the compound with the pigment uniformly dispersed
21 throughout the vehicle. If the application of the compound does not result in satisfactory
22 coverage, stop the method and begin water curing, as set out above, until the cause of the
23 defective work is corrected.

24 At locations where the coating shows discontinuities, pinholes or other defects, or if rain
25 falls on the newly coated surface before the film dries sufficiently to resist damage, apply
26 an additional coat of the compound at the same rate specified herein immediately after
27 the rain stops.

28 Completely remove any curing compound adhering to a surface to which new concrete is
29 to be bonded by sandblasting, steel wire brushes, bush hammers or other approved
30 means.

31 Protect the concrete surfaces to which the compound is applied from abrasion or other
32 damage that results in perforation of the membrane film for 7 curing days after placing
33 the concrete. If the film of membrane compound is damaged or removed before the
34 expiration of 7 curing days, immediately cure the exposed concrete by the water method
35 until the expiration of the 7 curing days or until applying additional curing compound.

36 If the application of curing compound is delayed, immediately start applying water as
37 provided in Subarticle 420-15(B) and continue until resuming or starting application of
38 the compound.

39 (D) Polyethylene Sheeting Method

40 Wet the exposed finished surface of concrete with water, using a nozzle that so atomizes
41 the flow to form a mist and not a spray, until the concrete sets, after which place the
42 white opaque polyethylene sheeting. Continue curing for 7 curing days after the concrete
43 is placed. If the sheeting is damaged or removed before the expiration of 7 curing days,
44 immediately cure the exposed concrete by the water method until placing additional
45 sheeting or until after 7 curing days.

46 Use sheeting which provides a complete continuous cover of the entire concrete surface.
47 Lap the sheets at least 12" and securely weigh down or cement them together to provide
48 a waterproof joint.

1 If any portion of the sheets is broken or damaged before the expiration of the curing
 2 period, immediately repair the broken or damaged portions with new sheets properly
 3 secured in place.

4 Do not use sections of sheeting damaged to such an extent as to render them unfit for
 5 curing the concrete.

6 **(E) Forms-in-Place Method**

7 As an option, cure surfaces of concrete by retaining the forms in place for at least
 8 7 curing days after placing the concrete.

9 If electing to leave forms in place for a part of the curing period and using one of the
 10 other methods of curing included in this article for the remainder of the curing period,
 11 keep the concrete surfaces wet during transition between curing methods.

12 **420-16 REMOVAL OF FORMS AND FALSEWORK**

13 Do not remove forms and falsework for the portions of structures listed in Table 420-1 until
 14 the concrete attains the compressive strength shown, as evidenced by approved,
 15 nondestructive test methods or by conducting compressive strength tests in accordance with
 16 AASHTO T 22 and T 23. Furnish approved equipment used for nondestructive tests.

TABLE 420-1 MINIMUM CONCRETE STRENGTH FOR REMOVAL OF FORMS AND FALSEWORK	
Portion of Structure	Minimum Compressive Strength, psi
Bridge Deck Slabs and overhangs for beam and girder bridges	3,000
Arch culverts, top slabs of box culverts, walls of box culverts when cast monolithically with the top slab or when the wall is 10 ft or more in height, caps and struts of substructures, diaphragms and other members subject to dead load bending	2,400

17 Remove forms for ornamental work, railing, parapets, walls less than 10 ft in height, curb
 18 faces on bridge superstructures and vertical surfaces that do not carry loads, any time after
 19 3 hours if the concrete is set sufficiently to permit form removal without damage to the
 20 member.

21 Do not remove forms used for insulation before the expiration of the minimum protective
 22 period required in Article 420-7.

23 Do not remove formwork for bent diaphragms until after casting deck concrete and allowing
 24 the concrete to attain a strength of 2,400 psi. As an option, to remove support from bent
 25 diaphragms before casting deck concrete, submit for approval a method to prevent the
 26 possibility of bent diaphragms slipping downward.

27 When removing forms before the end of the required curing period, use other curing methods
 28 to complete the required curing. When removing forms from underneath slabs before the end
 29 of the curing period, complete the curing in accordance with Subarticle 420-15(C).

30 **420-17 SURFACE FINISH**

31 **(A) General**

32 Finish all concrete as required by this article except for bridge decks. Use the type of
 33 finish called for in Subarticles 420-17(B) through 420-17(D), except where the contract
 34 requires a Class 1 or Class 2 surface finish. Apply epoxy protective coating as required
 35 by Article 420-18.

Section 420

1 (B) Ordinary Surface Finish

2 Apply ordinary surface finish to all formed concrete surfaces either as a final finish or
3 preparatory to a higher class finish. On surfaces backfilled or otherwise covered, or
4 enclosed surfaces, the removal of fins and form marks, the rubbing of grouted areas to
5 a uniform color, and the removal of stains and discoloration, is not required. Use
6 an ordinary surface finish, unless otherwise required, as final finish on all surfaces.

7 During the placing of concrete, take care to use methods of compaction that result in
8 a surface of even texture free from voids, water or air pockets, and that the coarse
9 aggregate is forced away from the forms to leave a mortar surface.

10 Immediately after removing the forms, clean and fill with grout all pockets, depressions,
11 honeycombs and other defects as directed. Remove all form ties or metal spacers to
12 a depth of at least 1" below the surface of the concrete then clean and fill the resulting
13 holes or depressions with grout. As an option, break off flush with the concrete surface
14 those metal devices with exposed cross-sectional area not exceeding 0.05 sq.in. on
15 surfaces permanently in contact with earth fill. Unless otherwise required, remove fins
16 and other projections flush with the concrete surface. Remove stains and discoloration.

17 Use grout for patching which contains cement and fine aggregate from the same sources
18 and in the same proportions as used in the concrete. Cure the grout in accordance with
19 Article 420-15. After the grout has thoroughly hardened, rub the surface with
20 a carborundum stone as required to match the texture and color of the adjacent concrete.

21 Obtain the final finish for railing in one of the following ways:

22 (1) Brush Finish

23 After striking off the concrete as described above, have skilled and experienced
24 concrete finishers thoroughly work and float the surface with a wooden, canvas or
25 cork float. Before this last finish sets, lightly stroke the surface with a fine brush to
26 remove the surface cement film, leaving a fine grained, smooth, but sanded texture.

27 (2) Float Finish

28 Finish the surface with a rough carpet float or other suitable device leaving the
29 surface even, but distinctly sandy or pebbled in texture.

30 (C) Unformed Surfaces Not Subjected to Wear

31 Finish all unformed surfaces not subjected to wear by placing an excess of material in the
32 forms and removing or striking off such excess with a wooden template, forcing the
33 coarse aggregate below the mortar surface. Do not use mortar topping for concrete
34 railing caps and other surfaces falling under this classification.

35 (D) Sidewalk, Islands or Stairways on Bridges

36 Strike off and compact fresh concrete until a layer of mortar is brought to the surface.
37 Finish the surface to grade and cross section with a float, trowel smooth and finish with
38 a broom. If water is necessary, apply it to the surface immediately before brooming.
39 Broom transverse to the line of traffic.

40 (E) Class 1 Surface Finish

41 In addition to Subarticle 420-17(B), as soon as the pointing sets sufficiently to permit,
42 thoroughly wet the entire surface with a brush and rub with a coarse carborundum stone
43 or other equally good abrasive, bringing the surface to a paste. Continue rubbing to
44 remove all form marks and projections, producing a smooth dense surface without pits or
45 irregularities.

1 Carefully spread or brush uniformly over the entire surface the material ground to a paste
2 by rubbing and allowing it to take a reset. After rubbing, cure the surface for 7 curing
3 days. Obtain the final finish by thoroughly rubbing with a fine carborundum stone or
4 other equally good abrasive. Continue this rubbing until the entire surface is of a smooth
5 texture and uniform color.

6 **(F) Class 2 Surface Finish**

7 In addition to Subarticle 420-17(B), after the pointing sets sufficiently to permit,
8 thoroughly wet and rub the entire surface with a coarse carborundum stone or other
9 equally good abrasive to bring the surface to a smooth texture and remove all form
10 marks. Finish the paste formed by rubbing as described above by carefully stroking with
11 a clean brush, or spread it uniformly over the surface and allow it to take a reset, then
12 finish it by floating with a canvas, carpet-faced or cork float; or rub down with dry
13 burlap.

14 **420-18 EPOXY COATING**

15 **(A) General**

16 Use a Type 4A flexible and moisture insensitive epoxy coating in accordance with
17 Section 1081. Provide a Type 3 material certification in accordance with Article 106-3
18 showing the proposed epoxy meets Type 4A requirements.

19 **(B) Surfaces**

20 Apply the epoxy protective coating to the top surface area, including chamfer area of bent
21 caps under expansion joints and of end bent caps, excluding areas under elastomeric
22 bearings. For cored slab and box beam bridges, do not apply the epoxy protective
23 coating to the bent or end bent caps.

24 Use extreme care to keep the area under the elastomeric bearings free of the epoxy
25 protective coating. Thoroughly clean all dust, dirt, grease, oil, laitance and other
26 objectionable material from the concrete surfaces to be coated. Air blast all surfaces
27 immediately before applying the protective coating.

28 Use only cleaning agents preapproved by the Engineer.

29 **(C) Application**

30 Apply epoxy protective coating only when the air temperature is at least 40°F and rising,
31 but less than 95°F and the surface temperature of the area to be coated is at least 40°F.
32 Remove any excess or free standing water from the surfaces before applying the coating.
33 Apply one coat of epoxy protective coating at a rate such that it covers between 100 and
34 200 sf/gal.

35 Under certain combinations of circumstances, the cured epoxy protective coating may
36 develop an oily condition on the surface due to amine blush. This condition is not
37 detrimental to the applied system.

38 Apply the coating so the entire designated surface of the concrete is covered and all pores
39 are filled. To provide a uniform appearance, use the exact same material on all visible
40 surfaces.

41 **420-19 PROTECTION OF SUBSTRUCTURE CONCRETE FROM RUST STAINS**

42 To prevent unpainted structural steel from staining substructure concrete, protect all final
43 exposed areas of the concrete from rust stains until casting the bridge deck and sealing the
44 expansion joints. Use an approved method for protecting the concrete.

45 Instead of the above, remove the stains by approved methods and cleaning agents.

Section 420

1 420-20 PLACING LOAD ON STRUCTURE MEMBERS

2 Do not place beams or girders on concrete substructures until the concrete in the substructure
3 develops a minimum compressive strength of 2,400 psi.

4 In addition to Article 410-8, do not place backfill or fill for retaining walls, abutments, piers,
5 wing walls or other structures that will retain material to an elevation higher on one side than
6 the other until the concrete develops the minimum specified strength for the class of concrete
7 required for the structure.

8 Do not carry backfill for arch culverts and box culverts to an elevation higher than one foot
9 above the top of footing or bottom slab until the concrete develops the minimum specified
10 strength for the class of concrete required for the culvert.

11 Adhere to the following time and strength requirements for erection of forms and construction
12 of superimposed bridge substructure elements:

13 (A) Wait at least 12 hours between placing footing or Drilled Pier concrete and erecting
14 column forms.

15 (B) Wait at least 24 hours between placing footing or Drilled Pier concrete and placing
16 column concrete.

17 (C) Wait at least 72 hours between placing column concrete and beginning erection of cap
18 forms or until column concrete attains a compressive strength of at least 1,500 psi.

19 (D) Wait at least 96 hours between placing column concrete and placing cap concrete or until
20 column concrete attains a compressive strength of at least 2,000 psi.

21 Do not place vehicles or construction equipment on a bridge deck until the deck concrete
22 develops the minimum specified 28 day compressive strength and attains an age of at least
23 14 curing days. The screed may be rolled across a previously cast bridge deck if the entire
24 pour has not achieved initial set. If any portion of the deck concrete has achieved initial set,
25 the screed cannot be rolled across the bridge deck until the concrete develops a compressive
26 strength of at least 1,500 psi. Construction equipment is allowed on bridge approach slabs
27 after the slab concrete develops a compressive strength of at least 3,000 psi and attains an age
28 of at least 7 curing days. See Subarticle 420-15(A) for the definition of "curing day."

29 Provide evidence that the minimum compressive strengths referred to above are satisfied by
30 nondestructive test methods approved in writing or by compressive strength tests made in
31 accordance with AASHTO T 22 and T 23. Furnish approved equipment for use in
32 nondestructive tests.

33 Do not place construction equipment, materials or other construction loads on any part of the
34 structure without permission. Submit 7 copies of the proposed plans for placing construction
35 loads on the structure for review, comments and acceptance.

36 Do not abruptly start or stop concrete trucks on bridge deck. Do not mix concrete in the truck
37 while on the deck. While machine forming concrete barrier rail or parapet, do not place any
38 equipment on the deck except one concrete truck and the equipment necessary to place the
39 concrete. Allow concrete barrier rail and parapet to attain a compressive strength of 3,000 psi
40 before placing any traffic on the deck other than equipment referenced above necessary to
41 construct any remaining barrier rail or parapet. Do not operate heavy equipment over any box
42 culvert until properly backfilling with a minimum cover of 3 ft.

43 420-21 MEASUREMENT AND PAYMENT

44 *Class ____ Concrete* will be measured and paid as the number of cubic yards of each class
45 that is incorporated into the completed and accepted structure except as indicated below. The
46 number of cubic yards of concrete is computed from the dimensions shown in the plans or
47 from revised dimensions authorized by the Engineer. When the foundation material is rock,
48 the number of cubic yards of footing concrete is computed by the average end area method

- 1 using the lower limits established for foundation excavation. The volume of concrete
2 displaced by piles other than steel piles is not included in the quantity to be paid.
- 3 *Grooving Bridge Floors* will be measured and be paid as the actual number of square feet
4 shown in the plans. Where the plans are revised, the quantity to be paid is the quantity shown
5 on the revised plans.
- 6 *Reinforced Concrete Deck Slab and Reinforced Concrete Deck Slab (Sand Lightweight
7 Concrete)* will be measured and paid as the number of square feet shown in the plans. No
8 separate payment will be made for furnishing and incorporating calcium nitrite corrosion
9 inhibitor when required by the plans.
- 10 The plan quantity is determined from the horizontal surface area using the nominal
11 dimensions and configuration shown in the Layout Sketch for computing surface area as
12 shown in the plans. Measure the transverse dimension out to the slab including raised median
13 and sidewalk sections. Consider diaphragms a portion of the slab. When required by the
14 plans, consider curtain walls, raised medians, sidewalks, pavement brackets, end posts, sign
15 mounts, luminaire brackets and any other concrete appurtenances or expansion joint material
16 a portion of the slab. Concrete barrier rail (including curved end blocks for the concrete
17 barrier rail, when used) is not considered a portion of the slab.
- 18 For structural steel spans, the quantities of concrete and reinforcing steel shown in the plans
19 are based on a metal stay-in-place forming method. These quantities include amounts for
20 1" additional concrete due to the corrugation of the metal forms, concrete diaphragms and,
21 when required by the plans, curtain walls, pavement brackets, end posts, raised medians,
22 sidewalks and other required attachments based on the profile grade and plan camber of the
23 girders.
- 24 For prestressed concrete girder spans, the quantities of concrete and reinforcing steel shown in
25 the plans are based on the forming method detailed in the plans. These quantities include
26 concrete diaphragms, and, when required by the plans, curtain walls, pavement brackets, end
27 posts, raised medians, sidewalks and other required attachments based on the profile grade
28 and plan camber of girders. The quantities include either cast-in-place slab concrete when the
29 plans are detailed for the prestressed concrete panel forming method or amounts for
30 1" additional concrete due to the corrugation of the metal forms when the plans are detailed
31 for the fabricated metal stay-in-place form forming method and based on the profile grade and
32 plan camber of the girders.
- 33 No measurement will be made for concrete or reinforcing steel due to a variation in camber of
34 the girders from the plan camber or for additional quantities required by optional methods of
35 forming.
- 36 No separate measurement or payment will be made for furnishing, installing and testing
37 anchor bolts or dowels. Payment at the contract unit prices for the various pay items will be
38 full compensation for all materials, equipment, tools, labor and incidentals necessary to
39 complete the work.
- 40 These prices and payments will be full compensation for all items required to construct
41 concrete structures. Remove forms and repair, remove or replace, as directed, concrete
42 containing plastic shrinkage cracks or other defects at no cost to the Department.
- 43 Payment will be made under:
- | Pay Item | Pay Unit |
|---|-----------------|
| Class ____ Concrete | Cubic Yard |
| Grooving Bridge Floors | Square Foot |
| Reinforced Concrete Deck Slab | Square Foot |
| Reinforced Concrete Deck Slab (Sand Lightweight Concrete) | Square Foot |

Section 422

**SECTION 422
BRIDGE APPROACH SLABS**

422-1 DESCRIPTION

Construct reinforced concrete slabs at bridge approaches, including subgrade, base course, curbs and sidewalks; furnish and place temporary slope drainage systems and subsurface drainage systems; remove existing pavement or approach slab; furnish and place concrete, reinforcing steel, joint filler, sealer and other materials; finish and cure concrete.

Construct the approach slabs after the adjacent bridge deck is cast and before constructing concrete barrier rails or sidewalks.

422-2 MATERIALS

Refer to Division 10.

Item	Section
Corrugated Aluminum Alloy Pipe	1032-2
Corrugated Polyethylene (PE) Pipe	1044-7
Corrugated Steel Pipe	1032-3
Curing Agents	1026
Joint Filler	1028-1
Joint Sealer	1028-3
Portland Cement Concrete	1000
Reinforcing Steel	1070
Stone, No. 78M	1005
Subdrain Fine Aggregate	1044-1

422-3 CONSTRUCTION METHODS

Construct the subgrade in accordance with Section 500.

Construct the asphalt concrete base course in accordance with Section 610.

Apply Section 420 to all concrete except as otherwise provided herein. Use Class AA concrete.

Finish and groove the reinforced concrete bridge approach slabs in accordance with Article 420-14, except do not groove the approach slabs when grooving the bridge deck is not required.

When grooving is not required, apply a broomed texture to the approach slabs before the concrete becomes non-plastic. Cure bridge approach slabs in the same manner as specified for bridge decks in Subarticle 420-15(B).

Temporarily cover or fill the opening in the joint at the end bent until installation of the joint seal. Make sure that the covering or filler provides for drainage off the bridge deck and keeps debris out of the joint and off the end bent cap.

Shape the concrete curb to match the face of the barrier rail. Do not place the curb within the limits shown in the plans until after sawing the joint at the end bent. Give the concrete a light broom finish with brush marks parallel to the curb.

When shown in the plans, construct sidewalks on bridge approach slabs in accordance with plan details. Do not construct sidewalks until sawing the joint at the end bent. Finish the concrete in accordance with Subarticle 420-17(D).

Include in the temporary slope drainage system the earth ditch block, erosion resistant surface material, Class B stone for erosion control and the pipe. Locate it as shown in the plans.

1 Use either corrugated polyethylene, corrugated steel or corrugated aluminum alloy for the
2 temporary drainage pipe. Do not use perforated pipe. Provide temporary pipe of sufficient
3 length for complete drainage away from the roadway embankment.

4 Backfill the approach slabs as soon as practical to prevent erosion adjacent to the slab.

5 **422-4 MEASUREMENT AND PAYMENT**

6 The price and payment below will be full compensation for all items required to construct
7 bridge approach slabs including, but not limited to, those items contained in Article 422-1.

8 *Bridge Approach Slabs, Sta. ____* will be paid at the contract lump sum price.

9 Grooving bridge approach slabs will be paid at the contract unit price per square foot for
10 *Grooving Bridge Decks* as provided in Article 420-21.

11 Payment will be made under:

Pay Item	Pay Unit
Bridge Approach Slabs, Sta. ____	Lump Sum

12

SECTION 425

13

FABRICATING AND PLACING REINFORCEMENT

14

425-1 DESCRIPTION

15 Furnish, fabricate and place steel reinforcement other than wire reinforcement, including all
16 related materials such as tie wire, separators, wire bar supports, mechanical butt splices for
17 reinforcing steel, and other material for fastening the reinforcing steel in place; galvanize
18 and/or coat where required; and fabricate, cut, bend, place and splice the reinforcement in
19 conformity with the shape and dimensions shown in the plans and as specified in these
20 *Standard Specifications*. Provide epoxy coated reinforcing steel where indicated in the plans.

21

425-2 MATERIALS

22

Refer to Division 10.

Item	Section
Epoxy Coated Reinforcing Steel	1070-7
Epoxy Coated Spiral Column Reinforcing Steel	1070-8
Mechanical Butt Splices for Reinforcing Steel	1070-9
Reinforcing Wire	1070-3
Spiral Column Reinforcing Steel	1070-8
Steel Bar Reinforcement	1070-2
Wire Bar Supports	1070-4
Wire Reinforcement	1070-3

23

425-3 PROTECTION OF MATERIALS

24

25 Protect steel reinforcement at all times from damage and make sure it is free from dirt, dust,
26 loose mill scale, loose rust, paint, oil or other foreign materials at the time of placement in the
work.

27

28 Store epoxy coated reinforcing steel bars at the project site at least one foot above the ground
29 on wooden or padded supports placed 10 ft apart, and completely cover with an opaque cloth,
30 canvas or woven fiber reinforced polyethylene white tarp. Do not use solid plastic sheeting.
31 Cover the bars such that adequate ventilation is provided to prevent condensation from
32 forming on the material during storage, and completely protect the bars from direct sunlight.
Do not allow water to pond under the epoxy coated reinforcing steel.

33

34 Store epoxy coated bars as close as possible to their final location in the structure to prevent
coating damage from unnecessary handling.

Section 425

1 Do not store epoxy coated bars at the project site from one construction season until the
2 following construction season unless stored in a waterproof enclosure.

3 **425-4 PLACING AND FASTENING**

4 Accurately place reinforcement as shown in the plans and secure firmly in position by wiring
5 at intersections and using metal bar supports, precast mortar blocks or other approved devices
6 of sufficient strength and location to resist distortion.

7 Tie reinforcing bars at all intersections except where spacing is less than one foot in both the
8 longitudinal and transverse directions, in which case tie at alternate intersections, as an option.
9 Securely tie each intersection of vertical reinforcing steel and spiral reinforcement for drilled
10 piers. Use plastic or epoxy coated spiral spacers with epoxy coated spiral column reinforcing
11 steel.

12 Provide wire bar supports for reinforcing steel in accordance with Article 1070-4 of the
13 proper height to provide the distance from the forms and the proper spacing between rows of
14 steel as indicated in the plans. When required by the plans, epoxy coat bar supports in
15 accordance with Article 1070-7. Provide rust-proofed supporting legs for wire bar supports
16 that rest on the forms as provided in Article 1070-4. When providing rust proofing by plastic
17 protection, make sure that the dipped plastic coating or premolded plastic tips are intact on
18 each bar support leg while concrete is placed.

19 Precast blocks, of approved shape and dimensions, for holding vertical reinforcement in
20 position from 1:2 mortar or concrete of the same mix used in the member being cast. Cure
21 precast blocks in accordance with Article 420-15 for the water method or the polyethylene
22 sheeting method. To hold vertical bars in position, use precast blocks which have embedded
23 wires extending from the block a sufficient distance to tie to the bar.

24 Roll wire reinforcement flat before placing concrete, unless otherwise shown in the plans.
25 Hold wire reinforcement firmly in place against vertical and transverse movement by
26 acceptable means.

27 Weld reinforcing steel in accordance with the American Welding Society's *Reinforcing Steel*
28 *Welding Code AWS D1.4* and only where required in the contract. Obtain written approval for
29 additional welding. Do not use tack welds unless approved.

30 Exercise extreme care when transporting, handling, placing and tying epoxy coated
31 reinforcing steel to prevent damage to the coating.

32 Immediately before placing epoxy coated reinforcing steel bars in the forms, visually inspect
33 each bar for coating damage. Ensure that all coating damaged by any cause is satisfactorily
34 repaired, including hairline cracks and that each bar, including bar ends, is completely
35 encapsulated in epoxy coating or patching material at the time of concrete placement. Make
36 coating repairs as described in Subarticle 1070-7(K) with material specified in
37 Subarticle 1070-7(C). Do not coat more than 5% of surface area on each bar with patching
38 material including patching due to damage to the coating by the coater, fabricator, transporter
39 or contractor. The patching limits do not include holiday repairs, overspray and coated ends
40 of bars.

41 Do not expose epoxy coated reinforcing steel to the weather for more than 30 days after
42 placing in the forms. If the concrete is not placed within 30 days, cover the epoxy coated
43 reinforcing steel as required by Article 425-3.

44 Do not place reinforcement while placing concrete in the member involved.

45 Place, allow inspection and obtain approval for reinforcement in any member before placing
46 concrete.

425-5 SPLICING**(A) General**

Furnish all reinforcement in the full lengths indicated in the plans.

Do not splice bars without written approval except where shown in the plans.

Provide splice lengths as shown in the plans.

Overlap sheets of wire reinforcement with each other sufficiently to maintain a uniform strength and securely fastened to each other at the ends and edges. Lap at least the dimension of one wire reinforcement.

(B) Mechanical Butt Splices

Provide mechanical butt slices for reinforcing steel in accordance with Article 1070-9 when called for in the plans.

Splice the bars in accordance with the manufacturer's recommendations using the manufacturer's required accessories as approved by the Engineer. Use mechanical butt splices only where specified in the plans. Any additional splices require approval.

425-6 MEASUREMENT AND PAYMENT

Reinforcing Steel or Epoxy Coated Reinforcing Steel will be measured and paid as the number of pounds of steel bar reinforcement, reinforcing wire and plain rods shown in the plans as being necessary to complete the work. Where the plans are revised, the quantity to be paid is the quantity shown on the revised plans. Where directed to deviate from the plans; changing the quantities of steel bar reinforcement, reinforcing wire and plain rods necessary to complete the project; the quantity shown in the plans is increased or decreased by the theoretical computed weight of reinforcing steel added or subtracted by the change.

Spiral Column Reinforcing Steel or Epoxy Coated Spiral Column Reinforcing Steel will be measured and paid as the number of pounds of spiral column reinforcing shown in the plans as being necessary to complete the work. Where the plans are revised, the quantity to be paid is the quantity shown on the revised plans. Where directed to deviate from the plans; changing the quantities of steel bar reinforcement, reinforcing wire and plain rods necessary to complete the project; the quantity shown in the plans is increased or decreased by the theoretical computed weight of spiral column reinforcing steel added or subtracted by the change.

The quantity of reinforcing steel or spiral column reinforcing steel shown in the plans is an estimate based on the theoretical computed weight of the steel necessary to complete the work and will be used for pay purposes. No revision in this pay quantity nor any adjustment in the contract unit price for *Reinforcing Steel* or *Spiral Column Reinforcing Steel* will be made except where revisions in the plans affect the quantity of reinforcing steel or spiral column reinforcing steel necessary to complete the work or where an error has been found in the estimate of steel shown in the plans.

If the elevation of the top of a footing or the tip of a drilled pier is raised by a distance not exceeding 3 ft, and the reinforcing steel or spiral column reinforcing steel for the substructure unit has been fabricated before the elevation was raised, no decrease in the quantity of steel to be paid will be made from the theoretical weight of steel shown in the plans for the original substructure unit. Under the above circumstances the provisions of Article 109-6 will not apply as the steel not used in the work shall remain the property of the Contractor and payment for such steel will be made as provided above. No separate payment will be made for the cost of cutting off reinforcing steel or spiral column reinforcing steel as payment at the contract unit price per pound for the item of Reinforcing Steel or Spiral Column Reinforcing Steel will be full compensation for cutting the steel.

Section 430

1 There will be no direct payment for reinforcing steel when the basis of payment or
2 compensation clause applicable to a particular section of the Specifications states that
3 payment at the contract unit or lump sum prices for the work covered by such section will be
4 full compensation for furnishing and placing reinforcing steel.

5 No separate payment will be made for the work of furnishing and placing wire reinforcement
6 as payment at the contract unit price for the item or items covering the structure containing
7 the wire reinforcement will be full compensation for such work.

8 These prices and payments will be full compensation for all items required to fabricate and
9 place reinforcement.

10 Payment will be made under:

Pay Item	Pay Unit
Reinforcing Steel	Pound
Epoxy Coated Reinforcing Steel	Pound
Spiral Column Reinforcing Steel	Pound
Epoxy Coated Spiral Column Reinforcing Steel	Pound

SECTION 430 ERECTING PRESTRESSED CONCRETE MEMBERS

14 430-1 DESCRIPTION

15 Furnish and erect precast-prestressed concrete bridge members other than piling. Furnish,
16 galvanize, place and paint, as applicable, bearing components, anchor bolts, washers, nuts,
17 structural and reinforcing steel, miscellaneous hardware, paint, bearing assemblies and all
18 other materials; handle, transport and store materials; furnish erection drawings; paint; set
19 bearings and anchorage; grout and erect and install the bridge members and all other items
20 necessary to complete the erection in accordance with the contract.

21 When used in this section, the term *prestressed concrete* refers to precast, pretensioned,
22 prestressed concrete.

23 430-2 MATERIALS

24 Refer to Division 10.

Item	Section
Bearing Plate Assemblies	1072-3
Elastomeric Bearings	1079-2
Organic Zinc Repair Paint	1080-9
Plain Steel Bars, Threaded Ends	1074-3
Precast-Prestressed Members	1078
Reinforcing Steel	1070
Structural Steel	1072

25 430-3 HANDLING AND STORAGE

26 Take special care in handling, transporting and storing prestressed members. Members
27 damaged while handled or transported will be rejected unless repaired to the satisfaction of
28 the Engineer.

29 Handle members at the bearings or at pick-up points designated in the plans unless using other
30 methods approved in writing.

31 Transport prestressed concrete bridge girders in a horizontal upright position. Locate points
32 of support and directions with respect to the girder approximately the same during
33 transportation and storage as when the member is in the final position within the structure.

430-4 METHODS AND EQUIPMENT

Use methods and equipment to install prestressed members that result in satisfactory installation.

430-5 BEARINGS AND ANCHORAGES

Supply elastomeric bearings, when required by the plans, meeting Section 1079.

Set steel sole plates level in exact position with full and even bearing on the bearing pad.

Accurately set anchor bolts in accordance with Subarticle 420-12(A).

When welding the sole plate to the embedded plate in the girder, use temperature indicating wax pens or other suitable means, to ensure that the temperature of the sole plate does not exceed 300°F. Temperatures above this may damage the elastomer.

Before welding, grind the galvanized surface of the portion of the embedded plate and sole plate that require welding. After welding, repair damaged galvanized surfaces in accordance with Article 1076-7.

430-6 ERECTION AND INSTALLATION**(A) General**

Erect prestressed concrete members by methods that satisfy the handling requirements specified in Article 430-3.

Perform field welding in accordance with Article 1072-18 only when required in the plans.

When indicated in the plans, recess the ends of tie rods used in intermediate diaphragms of prestressed concrete girders. Fill these recesses with an approved non-metallic, nonshrink grout to match the neat lines of the girders.

When concrete is cast in contact with prestressed members, thoroughly clean and wet the surface of the prestressed member which contacts the fresh concrete for at least 2 hours just before casting the fresh concrete.

After casting and finishing all concrete, thoroughly clean the prestressed members.

(B) Cored Slabs

When erecting prestressed cored slabs, place the 0.6" diameter transverse post tensioning strands and tension to 43,950 lb in each span. Grease the transverse strands and place in a non-corrosive 0.6" diameter, 1/16" minimum wall thickness black polyethylene pipe meeting [ASTM D2239](#). Do not apply grease or extend the pipe in the area of the recesses at the ends of the tensioning strands where grout is applied. After tensioning the 0.6" diameter transverse strand in a span and before placing any equipment, material or barrier rail on the span, fill the shear key, dowel holes and recesses at the ends of transverse strands with an approved non-metallic, nonshrink grout and cure for 3 days minimum and until the grout reaches a compressive strength of 3,000 psi.

After tensioning and curing, obtain approval before placing material and equipment on the cored slab spans. Support cranes or other equipment exceeding the legal load limit on mats. Submit for review a detailed drawing for the mats that are intended for use on the cored slabs. Provide a complete description of the equipment that is intended for placement on the mats. Supply and construct mats at no additional cost to the Department.

Section 430

(C) Box Beams

The post tensioning system shall use 0.6" diameter strands. Strands shall be tensioned to 43,950 lb. Strands shall be placed in a non-corrosive 0.6" diameter, 1/16" minimum wall thickness black polyethylene pipe meeting ASTM D2239.

Grease the strands and place in the polyethylene pipe. Do not apply grease or extend the pipe in the area of the recesses at the ends of the tensioning strands where grout is applied. Tension the strands in the diaphragm nearest mid-span first. Proceed to tension strands in the adjacent diaphragms. Continue the tensioning operation in a symmetric manner along the length of the span. At each diaphragm location, maintain a symmetric tension force between each pair of strands in the diaphragm. After all tensioning in a span is completed and before placing any equipment, material or barrier rail on the span, fill the shear key, dowel holes and recesses at the ends of the diaphragm with an approved non-metallic, nonshrink grout. Cure for 3 days minimum and until the grout reaches a compressive strength of 3,000 psi.

After tensioning and curing, obtain approval before placing material and equipment on the box beam spans. Support cranes or other equipment exceeding the legal load limit on mats. Submit for review a detailed drawing for the mats that are intended for use on the box beams. Provide a complete description of the equipment that is intended for placement on the mats. Supply and construct mats at no additional cost to the Department.

430-7 PAINTING

Clean, by hand or with power tools, and paint with 2 coats of organic zinc repair paint all ungalvanized steel surfaces, such as tie rod ends, not encased in concrete in accordance with Section 442. Provide a minimum dry thickness of each coat of paint of 1.5 mils.

430-8 MEASUREMENT AND PAYMENT

__" *Prestressed Concrete Girders* will be measured and paid as the number of linear feet of prestressed concrete girders estimated in the plans as being necessary to complete the project.

3'-0" x __'-__" *Prestressed Concrete Cored Slabs* will be measured and paid as the number of linear feet of prestressed concrete cored slabs estimated in the plans as being necessary to complete the project.

3'-0" x __'-__" *Prestressed Concrete Box Beams* will be measured and paid as the number of linear feet of prestressed concrete box beams estimated in the plans as being necessary to complete the project.

Concrete Box Beams will be measured and paid as the number of linear feet of concrete box beams estimated in the plans as being necessary to complete the project.

Elastomeric Bearings will be paid at the contract lump sum price.

These prices and payments will be full compensation for all items required to erect prestressed concrete members, including, but not limited to, those items contained in Article 430-1.

Payment will be made under:

Pay Item

- __" Prestressed Concrete Girders
- 3'-0" x __'-__" Prestressed Concrete Cored Slabs
- 3'-0" x __'-__" Prestressed Concrete Box Beams
- Concrete Box Beams
- Elastomeric Bearings

Pay Unit

- Linear Foot
- Linear Foot
- Linear Foot
- Linear Foot
- Lump Sum

**SECTION 440
STEEL STRUCTURES**

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440-1 DESCRIPTION

Construct steel structures and steel structure portions of composite structures in conformity with the lines, grades and dimensions shown in the plans and as specified in these specifications.

Furnish, fabricate, galvanize, deliver, place, erect, clean, shop paint and field paint structural metals and all other materials; furnish, erect and remove falsework; set bearings and anchorage; weld and furnish all materials for and assemble all structural joints. Structural metals include structural steels, metallic electrodes, steel forgings and castings, gray iron and malleable iron castings, drain pipes and any incidental metal construction.

Before starting work, inform the Engineer as to the proposed method of erection.

440-2 MATERIALS

Refer to Division 10.

Item	Section
Anchor Bolts	1072-4
Bearing Plate Assemblies	1072-3
Elastomeric Bearings	1079-2
High Strength Bolts, Nuts, Washers and Direct Tension Indicators	1072-5
Organic Zinc Repair Paint	1080-9
Preformed Bearing Pads	1079-1
Steel Pipe	1074-6
Structural Steel	1072
Welded Stud Shear Connectors	1072-6

440-3 HANDLING AND STORING MATERIALS

Move, handle and store all structural steel, in the shop, in the field and while being transported in accordance with Article 1072-9.

440-4 BEARINGS AND ANCHORAGES

Supply preformed bearing pads and elastomeric bearings, as required by the plans and in accordance with Section 1079.

Set steel masonry plates level in exact position with full and even bearing on the preformed bearing pad.

Accurately set anchor bolts in accordance with Subarticle 420-12(A).

Make sure that the location of anchors and setting of bearings take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom flange due to dead load after setting, so at mean temperature and under dead load the bearings are in a vertical position and anchor bolts at expansion bearings center in their slots. Mean temperature is 60°F unless otherwise stipulated in the plans. Do not restrict full and free movement of the superstructure at the movable bearings by improperly setting or adjusting bearings or anchor bolts and nuts.

440-5 STRAIGHTENING BENT MATERIAL, HEAT CURVING AND HEAT CAMBERING

Straighten bent material, heat curve and heat camber as approved and in accordance with Article 1072-10.

Section 440

1 **440-6 FIELD ERECTION**

2 Report immediately any error in the shop fabrication or deformation resulting from handling
3 and transporting, which prevents the proper assembling and fitting up of parts by more than
4 the moderate use of drift pins or by more than a moderate amount of reaming, chipping or
5 cutting. Correct errors in the presence of the Engineer by approved methods.

6 Do not perform hammering which injures or distorts the members.

7 Limit the drifting during assembly to only that needed to bring the parts into position, and not
8 sufficient to enlarge the holes or distort the metal. If any holes require enlarging to admit the
9 bolts, ream or correct them by approved methods. Do not enlarge the holes more than 1/16"
10 over the nominal size hole called for without written approval.

11 Before assembling the members, clean and dry to touch all bearing surfaces and permanently
12 contacting surfaces.

13 For bolted splices and field connections, fill one half of the holes with bolts and cylindrical
14 erection pins, at least half pins, before placing permanent fasteners. For continuous units, pin
15 and bolt all beam and girder splices and bring the splices to the correct elevations before
16 permanently fastening. For bolted connections use fit-up bolts and optional shipping bolts
17 with the same nominal diameter as the permanent fasteners, and use cylindrical erection pins
18 which are 1/32" larger. Use permanent bolts as fit-up bolts if desired.

19 Use temporary bolts, including, but not limited to, shipping and fit-up bolts, supplied with
20 square or hexagon heads and square or hexagon nuts. The use of hexagon head temporary
21 bolts and nuts is allowed, but paint both the head and nut with a durable yellow paint before
22 installation.

23 Do not reuse permanent bolts for final installation unless the nut is easily turned onto the bolt
24 for the full threaded length by hand and without use of tools.

25 The use of erection bolts for field welded joints is allowed. Use erection bolts that are
26 galvanized when the finish paint is applied in the structural steel fabrication shop and meet
27 AASHTO M 164. Supplement these bolts with clamps as necessary to meet the
28 AWS Specifications. Where unpainted AASHTO M 270 Grade 50W structural steel is used,
29 use erection bolts meeting AASHTO M 164 for Type 3 bolts.

30 After field welding the connection, leave the erection bolt in place with at least the minimum
31 bolt tension shown in Table 440-1. Use holes that are 3/16" larger than the nominal erection
32 bolt diameter.

33 **440-7 FIELD WELDING**

34 Perform field welding only when called for in the plans and in accordance with
35 Article 1072-18.

36 Remove paint, galvanizing or other coating at the location of field welds by blast cleaning
37 (SSPC SP-6 finish), hand cleaning (SSPC SP-2 finish) or power tool cleaning (SSPC SP-3
38 finish) just before welding. Clean sufficiently to prevent contamination of the weld by the
39 coating.

40 **440-8 CONNECTIONS USING HIGH STRENGTH BOLTS**

41 **(A) General**

42 This article covers the assembly of structural joints using plain or galvanized high
43 strength carbon steel bolts with suitable nuts and washers tightened to a high tension.
44 Use bolt holes that conform with Article 1072-16.

45 Protect bolts, nuts and washers from moisture during storage and so they show no signs
46 of rust at the time of installation.

- 1 Make sure that plain bolts and washers have a thin coat of lubricant at the time of
2 installation.
- 3 Use nuts that are pre-waxed by the producer or supplier before shipping to the project.
- 4 Apply beeswax, stick paraffin or other approved lubricant to the threads of galvanized
5 bolts just before installing the bolts.
- 6 Use bolt, nut and washer (when required) combinations from the same rotational-capacity
7 lot.
- 8 Perform the rotational capacity test described in Subarticle 1072-5(D)(4) on each
9 rotational-capacity lot before the start of bolt installation. Use hardened steel washers as
10 required by the test.

11 (B) Bolted Parts

- 12 Make sure that the slope of surfaces of bolted parts in contact with the bolt head and nut
13 does not exceed 1:20 with respect to a plane normal to the bolt axis. Make sure bolted
14 parts fit solidly together when assembled and are not separated by gaskets or any other
15 interposed compressible material. Provide contact surfaces, including those adjacent to
16 the bolt heads, nuts or washers, that are free of scale, dirt, burrs, oil, lacquer, loose rust,
17 rust inhibitor, other foreign material and other defects that prevent solid seating of the
18 parts.

19 (C) Installation

20 (1) Bolt Tensions

- 21 Tighten each fastener to provide at least the minimum bolt tension shown in
22 Table 440-1. Tighten fasteners with direct tension indicators in accordance with
23 Subarticle 440-8(C)(5), or if permitted, by the use of load indicating bolts as
24 provided in Subarticle 440-8(C)(3).

Bolt Size, Inches	Minimum Bolt Tension, Pounds
1/2	12,050
5/8	19,200
3/4	28,400
7/8	39,250
1	51,500
1 1/8	56,450
1 1/4	71,700
1 3/8	85,450
1 1/2	104,000

- 25 If necessary, because of bolt entering and wrench operation clearances, tighten by
26 turning the bolt while preventing the nut from rotating. Use impact wrenches, if
27 necessary, with adequate capacity and sufficiently supplied with air to perform the
28 required tightening of each bolt in approximately 10 seconds.

29 (2) Washers

- 30 Make sure all fasteners have a hardened washer under the element, nut or bolt head,
31 turned in tightening. Use galvanized washers when galvanized nuts and bolts are
32 required. As an exception to the above, use special washers for oversize, short-
33 slotted and long-slotted holes in accordance with Subarticle 1072-16(H).

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- 1 Where an outer face of the bolted parts has a slope of more than 1:20 with respect to
2 a plane normal to the bolt axis, use a smooth beveled washer to compensate for the
3 lack of parallelism.
- 4 (3) Load Indicating Bolts
- 5 Tightening by use of a load indicating bolt system is permitted provided it can be
6 demonstrated by an accurate direct measurement procedure that the bolt is tightened
7 in accordance with Table 440-1. Tighten by approved methods and procedures.
- 8 (4) Galvanized High Strength Bolts
- 9 Use mechanically galvanized high strength bolts in all bolted connections for painted
10 structural steel.
- 11 Install galvanized high strength bolts carefully so shop painted surfaces are not
12 scarred or otherwise damaged.
- 13 Repair galvanized surfaces that are abraded or damaged by thoroughly wire brushing
14 the damaged area and removing all loose and cracked coating, after which give the
15 cleaned area 2 coats of organic zinc repair paint.
- 16 (5) Direct Tension Indicators
- 17 Supply direct tension indicators in accordance with [ASTM F959](#) and Article 1072-5.
- 18 Furnish the Engineer with at least one metal feeler gauge for each container of direct
19 tension indicators shipped before beginning installation.
- 20 Make sure that the lot number on the containers of direct tension indicators is for the
21 same lot number tested as indicated on the test documents.
- 22 Furnish to the Engineer 3 samples of load indicating washers from each lot number,
23 each size and type for tests and 2 each of the metal feeler gauges required for
24 performing the tests.
- 25 Install the direct tension indicator under the bolt head. If it is necessary to install the
26 direct tension indicator under the nut, or if the bolt head shall be turned, install
27 additional hardened washers between the nut or bolt head and the direct tension
28 indicator.
- 29 Provide a tension indicating device on the project for determining the tension
30 imposed on a fastener when the protrusions on direct tension indicator are properly
31 compressed.
- 32 Test 3 samples from each lot of direct tension indicators in the presence of the
33 Engineer. Achieve a minimum bolt tension of 5% greater than that required by
34 Table 440-1 of Article 440-8.
- 35 Do not substitute direct tension indicators for hardened steel washers required with
36 short slotted or oversized holes. If desired, use direct tension indicators in
37 conjunction with hardened steel washers.
- 38 Install direct tension indicators initially to a snug tight condition. After initial
39 tightening, fully tighten beginning at the most rigid part of the joint and continuing
40 toward its free edges.
- 41 For tightening fasteners containing direct tension indicators, use a clean and
42 lubricated wrench. Maintain air supply and hoses in good condition and provide air
43 pressure of at least 100 psi at the wrench.

1 When tightening the fasteners, ensure that the part of the fastener being restrained
 2 from turning does not rotate during the tightening process. Ensure that no portion of
 3 the direct tension indicator protrusions is accidentally partially flattened before
 4 installing in the structural steel joints.

5 Do not reuse direct tension indicators. If it is necessary to loosen a bolt previously
 6 tensioned, discard and replace the direct tension indicator.

7 (D) Inspection

8 Allow the Engineer the opportunity to observe installation of bolts to determine that the
 9 selected tightening procedure is properly used. The Engineer determines when bolts are
 10 properly tightened and in the case of direct tension indicator bolts that the correct
 11 indication of tension is achieved. After properly tightening bolts, make sure that the end
 12 of the bolt is flush with or extended beyond the outer face of the nut.

13 Do not begin painting in the area of tightened bolts until after bolt inspection is complete.

14 When using direct tension indicators, proper tension of bolts is inspected by the Engineer
 15 by inserting a 0.005" thickness feeler gauge into the openings between adjacent flattened
 16 protrusions of the direct tension indicator. Proper tension is obtained when the number of
 17 spaces for which the gauge is refused is equal to or greater than the value shown in
 18 Table 440-2.

Number of Spaces in Washer	Number of Spaces Gauge is Refused
4	2
5	3
6	3
7	4

19 The gauge shall be refused in all spaces when the direct tension indicator is used under
 20 the turned element.

21 When using direct tension indicators, do not tighten bolts to a no visible gap condition.

22 Inspections of direct tension indicator installations are made by the Engineer by the use
 23 of the metal feeler gauges provided by the Contractor. At least 10%, but no less than 2 of
 24 the bolts in each connection are inspected with feeler gauges. Additionally, all remaining
 25 bolts in each connection are visually inspected for proper tightening.

26 **440-9 SURFACE PREPARATION AND PROTECTION OF WEATHERING STEEL**

27 After fabrication, shop clean all weathering steel remaining in the unpainted condition in the
 28 completed structure to a SSPC SP-6 finish. Provide a contact surface condition in accordance
 29 with Subarticle 442-7(B) at the time of bolt installation.

30 Protect the structural steel during concreting and any other operations that are particularly
 31 hazardous with respect to soiling the steel. Remove any foreign matter which gets on the steel
 32 as soon as possible by either solvent cleaning, hand tool cleaning, power tool cleaning, blast
 33 cleaning or a combination thereof, as necessary to restore the surfaces to the specified
 34 condition.

35 **440-10 MEASUREMENT AND PAYMENT**

36 *Approx. ____ Lbs. Structural Steel* will be measured and paid at the contract lump sum price.
 37 The approximate quantity shown in the contract pay item is an estimate based on the
 38 computed weight of the structural steel necessary to complete the work. No measurement for
 39 payment will be made for this pay item, and no adjustment in the contract lump sum price will
 40 be made for any variation from the approximate quantity shown except for revisions in the
 41 plans which affect the quantity of structural steel necessary to complete the work.

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- 1 When revisions in the plans have been made which affect the quantities of structural steel,
- 2 adjustments in compensation will be made by supplemental agreement.
- 3 When the contract includes the item of *Painting of Structural Steel*, all work of painting
- 4 except for shop painting will be paid as provided in Article 442-15 and payment for shop
- 5 painting will be included in the contract lump sum price for *Approx. ____ Lbs. Structural*
- 6 *Steel*. When the contract excludes the item of *Painting of Structural Steel*, payment at the
- 7 contract lump sum price for *Approx. ____ Lbs. Structural Steel* will be full compensation for
- 8 both shop and field painting.
- 9 *Elastomeric Bearings* will be paid as provided in Article 430-8.
- 10 The price and payment will be full compensation for all items required to construct steel
- 11 structures including, but not limited to, those items contained in Article 440-1.
- 12 Payment will be made under:

Pay Item	Pay Unit
Approx. ____ Lbs. Structural Steel	Lump Sum

SECTION 442
PAINTING STEEL STRUCTURES

442-1 DESCRIPTION

Paint steel structures and properly prepare metal surfaces; apply, protect and dry paint coatings; protect pedestrian, vehicular, water or other traffic upon or underneath the structure; protect all portions of the structure and adjacent work against disfigurement by splatters, splashes, overspray and smirches of paint or of paint materials; apply paint in the shop and field; and furnish blast cleaning equipment, paint spraying equipment, brushes, rollers, paint cleaning abrasives, cleaning solvents, tools, tackle, scaffolding, labor and any other materials, hand or power tools, inspection equipment and personal protective and safety equipment necessary for the entire work.

442-2 MATERIALS

Refer to Division 10.

Item	Section
Abrasive Materials for Blast Cleaning	1080-13
Paint and Paint Materials	1080

442-3 DEFINITIONS

Define “corner” as the intersection of 2 surfaces that are not in the same plane. Define “inaccessible areas” as partially or completely enclosed surfaces, the majority of which are not visible without the use of special devices such as mirrors. Define “sharp edge” as a corner on a steel section that ends in a point or edge and appears able to cut human flesh. Define “stripe coat” as an additional coat of paint applied to the edges, outside corners and areas difficult to coat by spray before or after a full coat is applied to the surface.

442-4 SUBMITTALS

Submit quality control plan, work schedule and Department test reports for each batch of paint to be used on the project. Submit product data sheets and MSDS sheets for paint and solvents used. Submit paint repair procedures for review and approval before commencing work.

1 442-5 PROTECTION OF WORK

2 Protect all parts of the structure against disfigurement by splatters, splashes, overspray and
3 smirches of paint or of paint materials. Assume responsibility for any damage or
4 disfigurement caused by operations to vehicles, persons or property, including plants and
5 animals; and provide protective measures to prevent such damage.

6 Thoroughly clean and restore any surface or surfaces disfigured by splatter, overspray,
7 splashes, smirches or other defects to its original condition.

8 Restore any damaged structure or surface to its original condition.

9 If traffic causes dust considered by the Engineer to be detrimental to the work, sprinkle dust
10 producing areas with water or dust palliative and take any other necessary precautions to
11 prevent the accumulation of dust and dirt on freshly painted surfaces.

12 442-6 QUALITY CONTROL

13 Both shop and field applicators are required to conduct and document quality control
14 inspection of the painting, including measurements of temperature, dew point, surface profile
15 and paint thickness. Make sure that the paint applicator has the Engineer's pre-approved
16 procedure for repair of all damage and defects. The personnel performing the QC tests for
17 this work shall be Department Certified Coating Level 1 inspectors.

18 442-7 SURFACE PREPARATION**19 (A) Blast Cleaning**

20 The blast profile shall be angular and between 1.0 and 3.0 mils when measured on
21 a smooth steel surface. The degree of cleaning required is indicated under the specified
22 paint system unless otherwise noted. Clean weathering steel surfaces to be painted to
23 achieve a SSPC SP-6 finish. Clean surfaces to be metalized to a SSPC-5 finish.
24 SSPC VIS-1 shall be used as a visual standard.

25 Blast clean by centrifugal or forced air blasters. When using forced air blasters use blast
26 nozzles with a minimum 5/16" orifice and operate at no less than 100 psi when measured
27 with a needle gauge at the nozzle. Use dry blasting for all blast cleaning. Select a size or
28 grade of abrasive that provides the specified finish and profile meeting Article 1080-13.

29 Perform blast cleaning operations so no damage is done to partially or entirely completed
30 portions of the work

31 After blasting, brush the surface with clean brushes made of hair, bristle or fiber; blow
32 off with compressed air; or clean by vacuum so any traces of blast products from the
33 surface and any abrasive from pockets and corners are removed. Perform surface
34 inspection once all blast abrasive and dust is removed from surface to be coated.

35 Use compressed air for nozzle blasting that is free of detrimental amounts of water or oil.
36 Provide adequate separators and traps. Verify cleanliness of air before blasting
37 operations in accordance with ASTM D4285.

38 Examine the blast cleaned surface for any traces of oil, grease or smudges deposited in
39 the cleaning operations. If present, remove them by an approved method. Ensure the
40 degree of cleanliness and profile are approved before painting.

41 When blast cleaning structures open to traffic, provide suitable protective enclosures to
42 prevent damage to public and private property. Do not blast directly over traffic without
43 prior approval of the Engineer. If the containment system is not effective in restricting
44 blasting emissions, blasting operations shall cease and deficiencies corrected before work
45 resuming.

46 Seal all journals, bearings, motors and moving parts against entry of abrasive dust before
47 blast cleaning near bridge machinery.

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1 Prime all blast cleaned surfaces to be painted no later than 8 hours after blast cleaning is
2 complete. Reclean the cleaned surfaces that contain rust or are contaminated with foreign
3 material before painting or bolting to the original surface preparation specifications.

4 (B) Hand or Power Tool Cleaning

5 Thoroughly remove loose paint, rust, scale, dirt, oil, grease and other detrimental
6 substances by hand cleaning (SSPC SP-2), power tool cleaning (SSPC SP-3) or any
7 combination of these methods. Hand cleaning includes the use of metal brushes,
8 grinders, sanders or any approved combination of these tools. Use bristle or wood fiber
9 brushes to remove loose dust.

10 442-8 PAINT SYSTEMS

11 Use all paints and solvents for shop and field application that are produced by the same
12 manufacturer.

13 Use approved/qualified paint products found in Section 1080. Apply the paint system
14 required by the plans and at the film thickness indicated below. Coating thickness in excess
15 of the maximum dry film thickness is acceptable as long as the coating is free of visible
16 defects such as runs, sags, curtains, cracking or lifting.

Coat	Material	Mils Dry/Wet Film Thickness	
		Min.	Max.
Primer	IOZ (See Section 1080-7.)	3.0 DFT	5.0 DFT
Intermediate	Brown (See Section 1080-11.)	2.0 DFT	4.0 DFT
Stripe	White (See Section 1080-11.)	4.0 WFT	7.0 WFT
Topcoat	Gray (See Section 1080-11.)	3.0 DFT	5.0 DFT
Total		8.0 DFT	14.0 DFT

17 Apply System 1 to non-weathering steel surfaces cleaned to an SSPC SP-10 finish. Shop
18 apply the IOZ primer, 2 coats of acrylic paint and one stripe coat of acrylic paint over all
19 structural steel surfaces except as otherwise specified. As an option, acrylic top coats may be
20 applied in the field.

21 Apply the primer to all bolt holes, plate snipes, shear connectors and all surfaces of the top
22 flange. If bubbling occurs during the application of the first field coat, apply a mist coat of
23 brown paint to prevent further bubbling.

24 Completely cure the inorganic zinc primer to meet [ASTM D4752](#) with at least a 4 resistance
25 rating before top coating.

26 Perform 2 random adhesion tests (one test is equal to 3 dollies) per span. Ensure that the
27 adhesion of the zinc primer is no less than 400 psi when tested in accordance with
28 [ASTM D4541](#).

29 Completely cure the acrylic intermediate and stripe coat to meet [ASTM D1640](#), Section 7.7,
30 ensure that there is no loosening, detachment, wrinkling or other evidence of distortion of the
31 film.

32 Perform one random cut tape adhesion test per span after the final coat is cured. Ensure that
33 the tape adhesion of the cured system is no less than 3A when tested in accordance with
34 [ASTM D3359](#).

35 Properly taper and touch up repair areas.

**TABLE 442-2
SYSTEM 2, INORGANIC ZINC (IOZ) PRIMER
AND COAL TAR EPOXY TOP COATS**

Coat	Material	Mils Dry/Wet Film Thickness	
		Min.	Max.
Primer	IOZ (See Section 1080-7.)	3.0 DFT	5.0 DFT
Intermediate	Red (See Section 1080-8.)	8.0 DFT	12.0 DFT
Topcoat	Black (See Section 1080-8.)	8.0 DFT	12.0 DFT
Total		19.0 DFT	NA

- 1 Apply System 2 on non-weathering steel surfaces cleaned to an SSPC SP-10 finish. Shop
- 2 painting consists of painting with a primer and 2 coats of coal tar epoxy paint over all
- 3 structural steel surfaces except as otherwise specified.
- 4 Completely cure the inorganic zinc primer to meet [ASTM D4752](#) with at least a 4 resistance
- 5 rating before top coating.
- 6 Perform 2 random adhesion tests, one test is equal to 3 dollies, per span. Ensure that the
- 7 adhesion of the zinc primer is at least 400 psi before top coating when tested in accordance
- 8 with [ASTM D4541](#).
- 9 Apply the finish coat when the first coat of coal tar epoxy is still tacky.

**TABLE 442-3
SYSTEM 3, ACRYLIC PRIMER AND TOP COATS**

Coat	Material	Mils Dry/Wet Film Thickness	
		Min.	Max.
Primer	Brown (See Section 1080-11.)	2.0 DFT	4.0 DFT
Intermediate	White (See Section 1080-11.)	2.0 DFT	4.0 DFT
Stripe	Brown (See Section 1080-11.)	4.0 WFT	7.0 WFT
Topcoat	Green (See Section 1080-11.)	2.0 DFT	4.0 DFT
Topcoat	Gray (See Section 1080-11.)	2.0 DFT	4.0 DFT
Total		8.0 DFT	16.0 DFT

- 10 Apply System 3 in the field or shop to non-weathering steel surfaces cleaned to an SSPC SP-6
- 11 finish. Painting consists of painting with 2 primer coats, a stripe coat and 2 finish coats over
- 12 all structural steel surfaces except as otherwise specified.
- 13 Provide a curing period for the first primer coat of paint of at least 24 hours. Perform one
- 14 random cut tape adhesion tests per span after final coat is cured. Ensure that the tape
- 15 adhesion of the cured system is at least 3A when tested in accordance with [ASTM D3359](#).
- 16 Properly taper and touch up repair areas.

**TABLE 442-4
SYSTEM 4, ACRYLIC PRIMER AND TOP COATS FOR WEATHERING STEEL**

Coat	Material	Mils Dry/Wet Film Thickness	
		Min.	Max.
Primer	Brown (See Section 1080-11.)	2.0 DFT	4.0 DFT
Intermediate	White (See Section 1080-11.)	3.0 DFT	5.0 DFT
Stripe	Brown (See Section 1080-11.)	4.0 WFT	7.0 WFT
Topcoat	Brown (See Section 1080-11.)	2.0 DFT	4.0 DFT
Total		7.0 DFT	13.0 DFT

- 17 Apply System 4 to weathering steel surfaces cleaned to an SSPC SP-6 finish. Shop painting
- 18 consists of applying all primer and finish paints at the ends of beams or girders within
- 19 a distance of 1.5 times the depth of the beam or girder at the bearing except as otherwise
- 20 specified.

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- 1 Provide a curing period for the first primer coat of paint of at least 24 hours.
- 2 Completely cure the acrylic intermediate and stripe coat to meet ASTM D1640, Section 7.7.
- 3 Ensure that there is no loosening, detachment, wrinkling or other evidence of distortion of the
- 4 film.
- 5 Perform one random cut tape adhesion test per span after the final coat is cured. Ensure that
- 6 the tape adhesion of the cured system is at least 3A when tested in accordance with
- 7 ASTM D3359.
- 8 Properly taper and touch up repair areas.

9 **442-9 APPLICATION OF PAINT**

10 **(A) General**

11 Unless otherwise permitted, apply all paint by spraying, except apply the stripe coat by
12 brush or roller. The use of a brush or roller is permitted to make minor repairs to the
13 primer.

14 Make sure that the applicator has a current copy of the paint manufacturer's application
15 instructions, along with MSDS for each paint; and furnish 2 copies to the Engineer.
16 Unless otherwise required herein, apply in accordance with the manufacturer's
17 instructions.

18 All paint materials shall be tested and approved by the Materials and Tests Unit before
19 application.

20 Paint in a neat and workmanlike manner. Apply the paint to provide a tight film of the
21 specified thickness, well bonded to the metal or previously applied paint, and free of laps,
22 streaks, sags or other defects.

23 Make sure each coat of paint is in a proper state of cure or dryness before applying the
24 succeeding coat.

25 Before successive coating application remove all contaminates, dry spray/overspray,
26 paint splatter and other non-adherent paint shall be removed before applying successive
27 coating layers. When necessary, clean each coat of paint in accordance with
28 Subarticle 442-7(B).

29 When a stripe coat is required, apply a 2" stripe by brush or roller to all exposed edges of
30 steel before applying the finish coat. Locate the edge or corner in the approximate center
31 of the paint stripe.

32 **(B) Application Conditions**

33 Unless the paint manufacturer's application instructions are more restrictive, obtain
34 written permission to apply paint if the temperature of the air or metal is not at least 40°F
35 and rising for inorganic zinc primers or 50°F and rising for acrylic paint or coal tar
36 epoxies, when freezing weather is forecast during the drying period, or when the metal is
37 hot enough to cause the paint to blister or produce a porous paint film.

38 Do not apply paint or perform any surface preparation when the air is misty; in the rain,
39 snow, fog, when wind velocity is continuously greater than 10 mph or when the steel
40 surface temperature is less than 5°F above the dew point. The humidity shall be less than
41 85% and lower when applying acrylic paints. Use ASTM E337 when performing
42 ambient conditions assessments.

43 Obtain written permission from the Engineer to apply field coats of paint between
44 November 15 of one year and April 15 of the following year inclusive. Do not apply any
45 coating above or below the manufacturers recommended application temperatures or
46 during a period when an ambient temperature outside the recommended range is
47 predicted during the drying and curing period of the paint.

1 Harsh environments may necessitate re-cleaning during or between paint applications.

2 **(C) Adverse Weather**

3 Obtain written approval to use enclosures during adverse weather conditions. Use
4 enclosures that control atmospheric conditions artificially inside within limits suitable for
5 painting during the painting operation and until the paint is dry/cured or until weather
6 conditions permit its exposure in the open.

7 **(D) Storage Conditions**

8 Provide adequate and safe storage for all paint and equipment. Do not expose paint
9 materials to rain, excessive condensation, long periods of direct sunlight or temperatures
10 above 110°F or below 40°F. Follow the manufacturer's storage requirements if more
11 restrictive.

12 Replace paint damaged by any cause.

13 **(E) Mixing Paint**

14 Mix paint in accordance with the manufacturer's instructions and Article 1080-1.

15 **(F) Thinning**

16 All paint thinning activities shall have prior approval. The paint products specified in
17 Section 1080 do not require thinning when applied under normal conditions. Obtain
18 written approval for any thinning necessitated by weather conditions or other causes.
19 Only those thinners approved by the paint manufacturer as described in the application
20 instructions are permitted.

21 **(G) Spray Application**

22 Use equipment for spray application of paint that is suitable for the intended purpose,
23 capable of properly atomizing the paint, and equipped with suitable pressure regulators
24 and gauges. Use air caps, nozzles and needles recommended by the manufacturer of the
25 equipment for the material being sprayed. Keep the equipment in satisfactory condition
26 to permit proper paint application. In closed or recirculating paint spray systems where
27 gas under pressure is used over the liquid, use an inert gas, such as nitrogen.

28 Provide and drain periodically during operations, adequately sized traps or separators to
29 remove oil and water from the compressed air. Make sure that the air from the spray gun
30 impinging against the surface shows no water or oil.

31 Use an agitated spray pot. Adjust the agitator or stirring rod to reach within 2" of the
32 bottom of the spray pot and be in motion at all times during paint application. Provide
33 sufficient motion to keep the paint well mixed.

34 Apply paint in a uniform layer, with overlapping at the edge of the spray pattern. Adjust
35 the spray pattern so the paint is deposited uniformly.

36 **(H) Stripe Coat**

37 When a stripe coat is required, apply a 2" stripe by brush or roller to all exposed edges of
38 steel before applying the finish coat. Locate the edge or corner in the approximate center
39 of the paint stripe. Brush apply stripe coat application on bolts, nuts, welds and other
40 obstructed locations. Roller apply stripe coat only on structural shape edges.

Section 442

1 442-10 SHOP PAINTING

2 (A) General

3 Shop painting is the painting of structural steel in an enclosed shop or plant before
4 shipment to the site of erection. The work in this section applies to previously uncoated
5 steel and includes the proper preparation of the metal surfaces and the application,
6 protection and cure/drying of coatings. Complete all shop fabrication, including welding
7 and attachment of shear connectors, before painting is started.

8 (B) Certification

9 In order to perform work for the project, all steel fabricators are required to establish
10 proof of their competency and responsibility in accordance with NCDOT's Structural
11 Steel Fabricator Qualification Program, and, where required, provide a shop certification
12 by American Institute Steel Construction (AISC) Sophisticated Paint Endorsement (SPE)
13 or Society of Protective Coatings (SSPC) Qualification Procedure Three (QP3) or
14 approved equivalent when the quantity is greater than 1,500 sf of painted steel.

15 (C) Painted Areas

16 (1) Do not paint the following surfaces:

- 17 (a) Bearing assemblies, plates and other galvanized or metallized parts.
- 18 (b) Areas where field welding is to be performed.
- 19 (c) Outside surfaces of splice plates (Systems 3 and 4 only).
- 20 (d) Plate surfaces contacting elastomeric bearing pads.
- 21 (e) Contact surfaces with blockouts for bolted connections on curved girder bridges
22 and beam and girder splices (Systems 3 and 4 only). In the areas of these
23 blockouts, extend the finish paint no closer than 2" nor more than 3" from the
24 edges of contact surfaces in bolted connections. Ensure that the primer paint is
25 clearly visible around these areas when the structural steel is assembled. The
26 same offset dimensions are required for finish paint at field welds, measured
27 from the proposed location of the field weld.

28 (2) Areas where paint is not required and overspray is permitted are shear connectors
29 and the top surface of the top flange.

30 (3) Clean and paint stiffener clips and other obstructed areas on a best effort basis. Such
31 areas are those that contain enclosed surfaces, the majority of which are not visible.

32 (4) Apply a stripe coat on all corners and raised welds.

33 (5) Provide a repair procedure for all damage and defects for approval before painting.

34 (6) Do not load material for shipment until at least 24 hours after applying the paint and
35 the paint is thoroughly dry.

36 (D) Surface Preparation

37 Prepare surface of steel surfaces in the shop in accordance with Article 442-7. Check
38 abrasives daily for contaminants or as otherwise directed by the Engineer. Verify that
39 abrasive material meets the cleanliness requirements of SSPC AB-1 or SSPC AB-2
40 depending on the abrasive material used.

1 The following items are required as a part of preparation and cleaning and shall be done
2 before application of the prime coat:

3 (1) Corner Condition

4 Bevel corners to an approximate 1/16" chamfer if the included angle is less than
5 90 degrees.

6 (2) Surface Irregularities

7 Remove slivers, hackles, tears and projection of blast cleaned steel. Restore the
8 profile in areas larger than one square foot.

9 (3) Weld Spatter

10 Remove excessive and loose weld spatter. Tightly adherent weld spatter is allowed
11 unless it is sharp. Flatten sharp weld spatter.

12 (4) Bolts

13 Shop installed galvanized bolts on which the coating is disturbed or distressed during
14 shop cleaning is of no concern as long as the coating system is applied over them. If
15 necessary, after installation, clean shop installed black bolts in accordance with
16 SSPC SP-1 solvent cleaning. Blast clean or otherwise clean by an approved
17 alternative method the bolts before shop priming.

18 **442-11 FIELD PAINTING**

19 **(A) General**

20 Field painting is conducted after erection, or when damage to a shop applied coating
21 system is repaired or when steel is otherwise painted outside an enclosed shop
22 environment.

23 Do not apply paint over traffic without prior written approval from the Engineer.

24 Touch-up of shop painted non-weathering steel consists of painting with primer and
25 finish paint over all the previously uncoated exposed metal surfaces. When the repair
26 area exceeds one square foot, clean, prime and topcoat damaged areas in accordance with
27 Subarticle 442-7(A); otherwise, clean, prime and topcoat damaged areas in accordance
28 with Subarticle 442-7(B). For systems with shop applied topcoats, apply an additional
29 field appearance coat of finish paint to the outside surface of all exterior beams on
30 non-weathering steel bridges over highways and navigable waterways.

31 When an appearance coat of finish paint is required, paint the portion of galvanized high
32 strength bolts on the outside face of exterior beams or girders with primer and appearance
33 coat of the finish paint. Apply the primer to the galvanized high strength bolts by brush,
34 so the primer is not applied to the adjacent finish paint.

35 At the location of field welds, satisfactorily remove all paint or galvanizing by blast
36 cleaning, hand cleaning or power tool cleaning just before welding. Clean sufficiently to
37 prevent contamination of the weld by the paint.

38 Final acceptance by the Engineer will be after erection of the structure, when the final
39 coat has been applied, and all repairs effected.

40 Clean all contaminants such as soil, concrete, weld splatter, grease or any other
41 deleterious material from the steel or shop coated surfaces before any painting operations
42 begin. Harsh environments may necessitate re-cleaning during or between paint
43 applications.

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1 (B) Certification

2 SSPC QP-1 certified contractor shall perform work that is not associated with Hazardous
3 Coating Removal operations.

4 442-12 PREPARATION FOR PAINTING GALVANIZED SURFACES

5 When painting galvanized surfaces is required in the plans, smooth, clean and prepare in
6 accordance with Section 1080 and this section. Provide shop certification in accordance with
7 Article 442-10 regardless of the quantity of painted steel.

8 Do not paint portions of galvanized piles encased in concrete below ground.

9 Smooth high spots and rough edges, such as metal drip lines, of galvanized surfaces in
10 accordance with **ASTM D6386**. Clean galvanized surfaces to be painted with a 2,500 psi
11 pressure washer. Allow surfaces to dry completely before beginning surface preparation.

12 Prepare galvanized surfaces to be painted by sweep blasting in accordance with
13 **ASTM D6386**. Use an abrasive material and technique that roughens the surface while
14 leaving base zinc layers intact. After sweep blasting, blow down blasted surfaces with clean,
15 dry, compressed air free of contamination.

16 Apply paint to clean, dry surfaces free of visible zinc oxides or zinc hydroxides within 8 hours
17 of surface preparation.

18 442-13 INSPECTION

19 Only Department Certified Coating Level 1 inspectors shall inspect the field-coating
20 application.

21 Ensure that the coating applicator maintains a daily quality control record. The information
22 required in the record is listed on Materials and Tests Form M&T-610. Maintain quality
23 control data in a log and format approved by the Engineer. Enter data daily or immediately as
24 coating activities are conducted. Ensure that the applicator's quality control representative
25 signs and dates each entry.

26 Apply all coatings in accordance with SSPC PA-1. Repair all coating defects or
27 nonconformities in accordance with SSPC PA-1. Make repairs to the topcoat with a uniform
28 gloss and color on visible surfaces. The Engineer makes the final decision concerning
29 uniformity and appearance.

30 442-14 REPAINTING OF EXISTING STEEL STRUCTURES

31 (A) Pollution Control

32 During field painting operations, use all necessary precautions to prevent dispersion of
33 surface preparation debris, paint or any other material outside the work area due to wind
34 or any other reason.

35 (B) Hazardous Paint Removal

36 Should the existing paint system include toxic substances such as red lead oxide, which is
37 considered hazardous if improperly removed, furnish a containment and spill control plan
38 for surface preparation and painting operations and await review and approval of said
39 plan before beginning work. This plan shall meet Class 2A in accordance with
40 SSPC Guide 6. This work shall be performed by a SSPC QP-2 certified contractor.

41 Monitor air quality. Any visible emissions outside the containment structure or air
42 quality monitoring results exceeding the permissible OSHA action level are justification
43 for suspension of the work. Monitor air quality at random locations within one foot to
44 5 ft from the enclosure in accordance with National Institute of Occupational Safety and
45 Health (NIOSH) Method 7082.

1 Immediately collect and retain any spilled dust or paint debris in approved containers. If
 2 a spill results in soil or water contamination, take all necessary actions to remediate the
 3 site to its original state.

4 **(C) Waste Handling**

5 Clean and dispose of any incidental material or equipment that is contaminated as the
 6 result of work performed.

7 **(D) Health and Safety Responsibility**

8 In addition to Article 105-11 and Sections 106 and 107, provide effective engineering and
 9 work practice controls to insure adequate protection.

10 Before beginning work, certify to the Engineer that all personnel involved with lead paint
 11 removal operations (including rigging and material handling personnel) are properly
 12 trained and understand the applicable parts of EPA, 40 CFR Part 745, OSHA Standards,
 13 29 CFR Part 1910 and 29 CFR Part 1926 including any amendments in force at the time
 14 of this contract.

15 **442-15 MEASUREMENT AND PAYMENT**

16 When the contract excludes the item of *Painting of Structural Steel*, there will be no direct
 17 payment for the work covered by this section.

18 When the contract includes the item of *Painting of Structural Steel*, all work covered by this
 19 section, except for shop painting, will be paid at the contract lump sum price for this item.
 20 Payment at the contract lump sum price for *Approximately ____ Pounds Structural Steel* as
 21 provided in Article 440-10 will be full compensation for the work of shop painting.

22 Repair or replacement of paint damaged by any cause will be incidental to the work of this
 23 section.

24 These prices and payments will be full compensation for all items required to paint steel
 25 structures including, but not limited to, those items contained in Article 442-1.

26 *Pollution Control* will be paid as the contract lump sum price.

27 When provided for in the contract, payment will be made under:

Pay Item	Pay Unit
Painting of Structural Steel	Lump Sum
Pollution Control	Lump Sum

28 **SECTION 450**
 29 **PILES**

30 **450-1 DESCRIPTION**

31 Furnish and install piles in accordance with the contract and accepted submittals. Provide
 32 steel and prestressed concrete piles and composite piles with both concrete and steel sections
 33 shown in the plans. Drive and drill in piles and use pile tips and accessories as shown in the
 34 plans. Galvanize, restrike, re-drive, splice, cut off and build up piles and perform predrilling,
 35 spudding and pile driving analyzer testing as necessary or required.

36 Define "pile embedment" as the required pile embedment in the cap or footing and "pile
 37 penetration" as the minimum required pile tip elevation or penetration into natural ground,
 38 whichever is deeper. Define "natural ground" as below the ground or mud line before
 39 constructing any embankments.

40 The estimated pile lengths shown in the plans are for bid purposes only. Provide piles of
 41 sufficient lengths for the required driving resistance, pile embedment and pile penetration.
 42 Determine required pile lengths by performing subsurface investigations, as needed.

Section 450

1 450-2 MATERIALS

2 Refer to Division 10.

Item	Section
Flowable Fill, Non-Excavatable	1000-6
Neat Cement Grout, Nonshrink	1003
Portland Cement Concrete, Class A	1000
Reinforcing Steel	1070
Steel and Prestressed Concrete Piles	1084-1
Steel Pipe Pile Plates	1072

3 For drilled-in piles, use Class A concrete that meets Article 1000-4 except as modified herein.
4 Provide concrete with a slump of 6" to 8". Use an approved high-range water reducer to
5 achieve this slump.

6 For composite piles with both prestressed concrete and steel H-pile sections, use prestressed
7 concrete piles and steel H-piles that meet Section 1084. Use steel pile points and splicers
8 approved by the Materials and Tests Unit.

9 450-3 CONSTRUCTION METHODS

10 (A) Handling and Storing Piles

11 Handle, transport and store piles so piles are kept clean and undamaged. Do not use
12 chains, cables or hooks that can damage or scar piles. Do not damage coatings on steel
13 piles. When handling prestressed concrete piles, support piles at pick-up points shown in
14 the plans.

15 Protect steel piles from corrosion. Store piles above ground upon platform skids, or other
16 supports, and keep free from dirt, grease, vegetation and other foreign material.

17 (B) Pile Installation

18 If applicable, completely excavate for caps or footings before installing piles.
19 If applicable and unless noted otherwise in the plans, construct embankments to bottom
20 of cap or footing elevations for a horizontal distance of 50 ft from any pile except where
21 fill slopes are within 50 ft of a pile.

22 Install piles with the following tolerances:

23 (1) Axial alignment within 1/4"/ft of vertical or batter shown in the plans,

24 (2) Horizontal alignment within 3" of plan location, and

25 (3) Pile embedment within 3" more and 2" less of the embedment shown in the plans.

26 If necessary, build up prestressed concrete piles or splice steel piles as shown in the
27 plans. Do not use more than 3 sections (2 splices) of steel piling per pile. Cut off piles at
28 required elevations along a plane normal to the axis of the pile as necessary. Do not
29 damage or spall piles when cutting off prestressed concrete piles.

30 (C) Pile Accessories

31 When required, use pile accessories including pipe pile plates and steel pile points and
32 splicers shown in the plans. Weld pipe pile plates to steel pipe piles as shown in the
33 plans.

34 Attach steel pile points to steel piles in accordance with the manufacturer's instructions.
35 Weld a minimum length of twice the flange width for steel H-piles.

36 Use steel pile tips with prestressed concrete piles as shown in the plans. Use steel pile
37 splicers for splicing steel H-pile tips and composite piles. Attach steel pile splicers in
38 accordance with the manufacturer's instructions.

(D) Driven Piles

Do not drive piles within 50 ft of cast-in-place concrete until the concrete cures for at least 3 days. Do not use vibratory hammers to install prestressed concrete piles.

When predrilling, spudding and installing the initial portions of steel piles with vibratory hammers, submit these pile installation methods with the proposed pile driving methods and equipment for acceptance. Define “spudding” as driving or dropping a steel H-pile and then removing it. The Engineer will approve the spudding depth and H-pile size, predrilling depth and diameter and depth of pile installation with a vibratory hammer.

Limit driving stresses in accordance with the *AASHTO LRFD Bridge Design Specifications*. If a tip elevation is noted in the plans, drive steel and prestressed concrete piles to the minimum required driving resistance and tip elevation. Otherwise, drive steel and prestressed concrete piles to the minimum required driving resistance and at least 10 ft into natural ground. Drive composite piles to the minimum required driving resistance and the prestressed concrete and steel H-pile sections to their respective minimum required tip elevations noted in the plans.

Drive piles continuously to the required pile penetration unless stopped due to exceeding the maximum blow count or driving stresses, insufficient pile length or other approved reasons. Redrive piles raised or moved laterally due to driving adjacent piles.

Protect coatings in an approved manner when driving coated steel piles through templates. Repair damaged galvanizing in accordance with Article 1076-4.

(1) Predrilling and Spudding

If necessary or required, perform predrilling and spudding as noted in the plans and in accordance with the accepted submittals. Predrill pile locations to elevations noted in the plans or approved by the Engineer. When noted in the plans and at the Contractor’s option, spudding may be used instead of predrilling. Do not perform spudding below predrilling elevations noted in the plans or approved by the Engineer.

When noted in the plans or predrilling in water or wetlands, use temporary steel casings that meet Subarticle 450-3(E)(1), except use steel casings with inside diameters no more than 2" larger than predrilling diameters. Use temporary casings from at least 2 ft above the static water elevation or ground line, whichever is higher, to at least 5 ft below the ground or mud line. More than 5 ft embedment may be necessary if temporary casings are not stable or predrilling or spudding disturbs material outside casings.

Perform predrilling and spudding so spoils are minimized, large ground movements and voids below ground do not occur and piles can be driven to the required resistance and pile penetration. Do not deposit spoils in water or wetlands. Remove all temporary casings before driving piles.

(2) Driving Equipment

Submit the proposed pile driving methods and equipment (pile driving equipment data form) including the pile driving hammer, hammer cushion, pile helmet and cushion for all piles for acceptance. Do not submit more than 2 pile driving hammers per pile type per submittal. Provide 2 copies of each data form at least 30 days before driving piles. All equipment is subject to satisfactory field performance.

Drive piles with accepted driving equipment and operate pile driving hammers in accordance with the manufacturer’s recommendations. Use hammers that will not overstress piles and attain the required driving resistance between 30 and 180 blows/ft. Use variable energy hammers to drive prestressed concrete piles.

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1 Operate air and steam hammers within 10% of the manufacturer's rated speed or
2 a rate approved by the Engineer. Use a plant and equipment for air or steam
3 hammers with sufficient capacity to maintain, under working conditions, the
4 manufacturer's recommended volume and pressure. Equip the plant and equipment
5 with accurate pressure gauges that are easily accessible. Provide striking parts of air
6 and steam hammers weighing at least 2,750 lb and one-third the pile helmet and pile
7 weight.

8 Equip open-end (single acting) diesel hammers with a graduated scale (jump stick)
9 extending above the ram cylinder, graduated rings or grooves on the ram or
10 an electric sound activated remote measuring instrument to determine the hammer
11 stroke during driving. Equip closed-end (double acting) diesel hammers with
12 a calibrated bounce chamber pressure gauge mounted near the ground and provide
13 a current calibrated chart or graph equating bounce chamber pressure and gauge hose
14 length to equivalent energy. Submit this chart or graph with the proposed pile
15 driving methods and equipment for closed-end diesel hammers.

16 The Engineer may inspect the hammer cushion before beginning and occasionally
17 during driving. Expose the hammer cushion for inspection as directed. Replace or
18 repair any hammer cushion that is less than 25% of its original thickness.

19 Hold pile heads in position with pile helmets that closely fit over pile heads and
20 extend down the sides of piles a sufficient distance. Protect pile heads of prestressed
21 concrete piles from direct impact with accepted pile cushions. Use pile cushions
22 made of pine plywood with a thickness of at least 4". Provide a new pile cushion for
23 each prestressed concrete pile. Replace pile cushions during driving when a cushion
24 is compressed more than 50% of its original thickness or begins to burn.

25 (3) Required Driving Resistance

26 The Engineer will determine the acceptability of the proposed pile driving methods
27 and equipment and provide the blows/ft and equivalent set for the required driving
28 resistance. The minimum required driving resistance is equal to the factored
29 resistance noted in the plans plus any additional resistance for downdrag and scour,
30 if applicable, divided by a resistance factor.

31 Stop driving piles when refusal is reached. Define "refusal" as 240 blows/ft or any
32 equivalent set.

33 (4) Restriking and Redriving Piles

34 After reaching the required pile penetration, the Contractor may choose to or the
35 Engineer may require the Contractor to stop driving, wait and restrike or redrive
36 piles to attain the required driving resistance. When the Engineer requires restrikes
37 or redrives, the Engineer will determine the number of restrikes or redrives and the
38 time to wait after stopping driving and between restrikes and redrives. The time to
39 wait will range from 4 to 24 hours.

40 Use the same pile driving methods, equipment and compressed pile cushion from the
41 previous driving to restrike or redrive piles unless the cushion is unacceptable due to
42 deterioration. Do not use cold diesel hammers for restrikes or redrives, unless it is
43 impractical to do otherwise as determined by the Engineer. In general, warm up
44 hammers by applying at least 20 blows to a previously driven pile or timber mats on
45 the ground.

(E) Drilled-in Piles

Perform pile excavation to elevations shown in the plans or approved by the Engineer. Excavate holes at pile locations with diameters that will result in at least 3" of clearance all around piles. Before filling holes, support and center piles in excavations and when noted in the plans, drive piles to the required driving resistance. Remove any fluids from excavations and, at the Contractor's option, fill holes with concrete, grout or flowable fill unless required otherwise in the contract.

(1) Pile Excavation

Use equipment with sufficient capacity to drill through soil, rock, boulders, timbers, man-made objects and any other materials encountered. Do not use blasting to advance pile excavations. Blasting for core removal is only permitted when approved by the Engineer. Contain and dispose of drilling spoils as directed and in accordance with Section 802. Drilling spoils consist of all materials and fluids removed from pile excavations.

If unstable, caving or sloughing soils are anticipated or encountered, use slurry or temporary steel casings to stabilize holes. When using slurry, submit slurry details including product information and additives, manufacturer's recommendations for use, slurry equipment details and documentation that mixing water is suitable for slurry before beginning drilling. When using temporary casings, use smooth or corrugated clean watertight steel casings of ample strength to withstand handling and installation stresses and pressures imposed by concrete, earth, backfill and fluids. Use steel casings with an outside diameter equal to the hole size and a wall thickness of at least 1/4".

(2) Filling Holes

Check the water inflow rate at the bottom of holes after all pumps have been removed. If the water inflow rate is greater than 6" per half hour or holes are stabilized with slurry, use an approved method for placing concrete, grout or flowable fill. Otherwise, remove any fluids and free fall concrete, grout or flowable fill into holes. Ensure that concrete, grout or flowable fill flows completely around piles. Place concrete, grout or flowable fill continuously and remove all temporary casings.

(F) Pile Driving Analyzer

When required, test piles in accordance with ASTM D4945 using a pile driving analyzer (PDA) manufactured by Pile Dynamics, Inc. Analyze PDA data with the CAsE Pile Wave Analysis Program (CAPWAP) manufactured by Pile Dynamics, Inc. Use a prequalified PDA Consultant to perform PDA testing and CAPWAP analyses and provide PDA reports. Use a PDA Operator approved as a Field Engineer (key person) for the PDA Consultant. Provide PDA reports sealed by an engineer approved as a Project Engineer (key person) for the same PDA Consultant.

The Engineer will determine how many and which piles require PDA testing. Provide piles for PDA testing that are at least 5 ft longer than the estimated pile lengths shown in the plans. Do not drive piles until the proposed pile driving methods and equipment have been preliminarily accepted. Notify the Engineer of the pile driving schedule at least 7 days in advance.

The Engineer will complete the review of the proposed pile driving methods and equipment within 10 days of receiving PDA reports. A PDA report for or PDA testing on multiple piles may be required as determined by the Engineer before the 10 day time period begins.

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1 (1) PDA Testing

2 If necessary, provide a shelter to protect the PDA Operator and equipment from
3 conditions of sun, water, wind and temperature. The shelter should have a floor size
4 of at least 6 ft x 6 ft and a roof height of at least 8 ft. If necessary, heat or cool the
5 shelter to maintain a temperature between 50°F and 85°F. Place the shelter within
6 reach of the PDA cables and clear view of piles being driven.

7 Drill holes for PDA instruments as directed. Place piles in leads and templates
8 before attaching PDA instruments. Use only preliminarily accepted pile driving
9 methods and equipment to drive piles. Drive piles as directed and in accordance
10 with Subarticle 450-3(D). The PDA Operator or Engineer may require modified pile
11 installation procedures during driving. Dynamic measurements will be recorded and
12 used to evaluate the hammer performance, driving resistance and stresses, energy
13 transfer, pile integrity and various soil parameters such as quake and damping.

14 If required, reattach PDA instruments and restrike or redrive piles in accordance with
15 Subarticle 450-3(D)(4). Obtain the required stroke and at least 6" of pile movement
16 as directed. Dynamic measurements will be recorded during restriking and
17 redriving. The Engineer will determine when PDA testing has been satisfactorily
18 completed.

19 (2) CAPWAP Analysis

20 CAPWAP analysis is required for at least a hammer blow near the end of initial drive
21 and each restrike and redrive. Additional CAPWAP analyses may be required as
22 determined by the PDA Consultant or Engineer.

23 (3) PDA Reports

24 Submit 2 copies of each PDA report within 7 days of completing PDA testing.
25 Include the following in PDA reports:

26 (a) Title Sheet

- 27 (i) Department's TIP number and WBS element number
- 28 (ii) Project description
- 29 (iii) County
- 30 (iv) Bridge station number
- 31 (v) Pile location
- 32 (vi) Personnel
- 33 (vii) Report date

34 (b) Introduction

35 (c) Site and Subsurface Conditions (including water table elevation)

36 (d) Pile Details (including driving dates and times)

- 37 (i) Pile type and length
- 38 (ii) Required driving resistance and resistance factor
- 39 (iii) Concrete compressive strength or steel yield strength
- 40 (iv) Pile splice type and locations
- 41 (v) Pile batter
- 42 (vi) Installation methods including use of predrilling, spudding, vibratory
43 hammer, template, barge, etc.

- 1 (e) Driving Details
- 2 (i) Hammer make, model and type
- 3 (ii) Hammer and pile cushion type and thickness
- 4 (iii) Pile helmet weight
- 5 (iv) Hammer efficiency and operation data including fuel settings, bounce
- 6 chamber pressure, blows per minute, equipment volume and pressure
- 7 (v) Driving data (ram stroke, blows/ft and set for last 10 hammer blows)
- 8 (vi) Ground or mud line, template reference and final pile tip elevations
- 9 (vii) Restrike and redrive information
- 10 (f) PDA Field Work Details
- 11 (g) CAPWAP Analysis Results
- 12 (i) Table showing percent skin and tip, skin and toe damping, skin and toe
- 13 quake and match quality
- 14 (h) Summary/Conclusions
- 15 (i) Attachments
- 16 (i) Boring log(s)
- 17 (ii) Pile driving equipment data form (from Contractor)
- 18 (iii) Field pile driving inspection data (from Engineer)
- 19 (iv) Accelerometer and strain gauge serial numbers, calibration and locations
- 20 (v) PDA hardware model and CAPWAP software version information
- 21 (vi) PDF copy of all PDA data and executable CAPWAP input and output files

22 **450-4 MEASUREMENT AND PAYMENT**

23 No additional payment will be made for subsurface investigations to determine required pile

24 lengths or larger caps or footings due to piles out of position.

25 ____ *Prestressed Concrete Piles*, ____ *Steel Piles* and ____ *Galvanized Steel Piles* will be

26 measured and paid in linear feet. Steel and prestressed concrete piles will be measured as the

27 pile length before installation minus any pile cut-offs. No payment will be made for pile

28 cut-offs or cutting off piles. No payment will be made for damaged, defective or rejected

29 piles or any piles for falsework, bracing, templates or temporary work bridges. The contract

30 unit prices for ____ *Prestressed Concrete Piles*, ____ *Steel Piles* and ____ *Galvanized Steel*

31 *Piles* will be full compensation for driving piles.

32 Composite piles will be measured as the pile length of the prestressed concrete and steel

33 H-pile sections before installation minus any pile cut-offs. The concrete and steel sections

34 will be measured and paid at the contract unit prices for ____ *Prestressed Concrete Piles* and

35 ____ *Steel Piles*, respectively. No payment will be made for portions of steel H-pile sections

36 embedded in prestressed concrete sections or steel pile splicers and any associated hardware

37 or welding.

38 After piles attain the required resistance and pile penetration and at the Contractor's option,

39 drive piles to grade instead of cutting off piles provided the remaining portions of piles do not

40 exceed 5 ft and piles can be driven without damage or reaching the maximum blow count or

41 refusal. When this occurs, the additional pile length driven will be measured and paid at the

42 contract unit prices for ____ *Prestressed Concrete Piles*, ____ *Steel Piles* and

43 ____ *Galvanized Steel Piles*.

44 For prestressed concrete piles that are built up, the build-up will be measured and paid at the

45 contract unit price for ____ *Prestressed Concrete Piles*. Steel pile tips are not included in the

46 measurement of prestressed concrete piles. No separate payment will be made for steel pile

47 tips or splicers and any associated hardware or welding. Steel pile tips and steel pile splicers

48 will be incidental to the contract unit price for ____ *Prestressed Concrete Piles*.

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- 1 *Steel Pile Points* and *Pipe Pile Plates* will be measured and paid in units of each. *Steel Pile*
- 2 *Points* and *Pipe Pile Plates* will be measured as one per pile.
- 3 *Predrilling for Piles* will be measured and paid in linear feet. For bents with a predrilling pay
- 4 item shown in the plans, predrilling will be paid as *Predrilling for Piles* and measured per pile
- 5 location as the depth from the ground or mud line to the specified predrilling elevation or
- 6 revised elevation approved by the Engineer. The contract unit price for *Predrilling for Piles*
- 7 will also be full compensation for using temporary casings. For bents without a predrilling
- 8 pay item shown in the plans, predrilling will be incidental to the contract unit prices for
- 9 ____ *Prestressed Concrete Piles*, ____ *Steel Piles* and ____ *Galvanized Steel Piles*.
- 10 No direct payment will be made for spudding. Spudding will be incidental to the contract unit
- 11 prices for ____ *Prestressed Concrete Piles*, ____ *Steel Piles* and ____ *Galvanized Steel Piles*.
- 12 *Pile Redrives* will be measured and paid in units of each. *Pile Redrives* will be measured as
- 13 the number of restrikes or redrives required by the Engineer. No payment will be made for
- 14 restrikes or redrives when the Contractor chooses to restrike or redrive piles.
- 15 *Pile Excavation in Soil* and *Pile Excavation Not in Soil* will be measured and paid in linear
- 16 feet. Pile excavation will be measured as the depth from the ground line to the specified pile
- 17 excavation elevation or revised elevation approved by the Engineer. Define “not in soil” as
- 18 material with a rock auger penetration rate of less than 2" per 5 minutes of drilling at full
- 19 crowd force. When not in soil is encountered, seams, voids and weathered rock less than 3 ft
- 20 thick with a rock auger penetration rate of greater than 2" per 5 minutes of drilling at full
- 21 crowd force will be paid at the contract unit price for *Pile Excavation Not in Soil*. Seams,
- 22 voids and weathered rock greater than 3 ft thick will be paid at the contract unit price for *Pile*
- 23 *Excavation in Soil* where not in soil is no longer encountered. The contract unit prices for
- 24 *Pile Excavation in Soil* and *Pile Excavation Not in Soil* will be full compensation for
- 25 stabilizing and filling holes with concrete, grout or flowable fill.
- 26 *PDA Testing* will be measured and paid in units of each. *PDA Testing* will be measured as
- 27 one per pile. The contract unit price for *PDA Testing* will be full compensation for
- 28 performing PDA testing the first time a pile is tested, performing CAPWAP analyses on data
- 29 collected during initial drive, restrikes and redrives and providing PDA reports. Subsequent
- 30 PDA testing of the same piles will be incidental to the contract unit price for *Pile Redrives*.
- 31 The contract unit price for *PDA Testing* will also be full compensation for the Contractor’s
- 32 assistance to perform PDA testing during initial drive, restrikes and redrives.
- 33 Payment will be made under:

Pay Item	Pay Unit
____ Prestressed Concrete Piles	Linear Foot
____ Steel Piles	Linear Foot
____ Galvanized Steel Piles	Linear Foot
Steel Pile Points	Each
Pipe Pile Plates	Each
Predrilling for Piles	Linear Foot
Pile Redrives	Each
Pile Excavation in Soil	Linear Foot
Pile Excavation Not in Soil	Linear Foot
PDA Testing	Each

SECTION 452
SHEET PILE RETAINING WALLS

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452-1 DESCRIPTION

Construct sheet pile retaining walls consisting of steel sheet piles for permanent applications. Provide cast-in-place reinforced concrete coping as required. Construct sheet pile retaining walls with the required embedment below bottom of wall elevations in accordance with the contract and accepted submittals. Define a “sheet pile wall” as a sheet pile retaining wall.

452-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Agents	1026
Joint Materials	1028
Portland Cement Concrete, Class A	1000
Reinforcing Steel	1070
Steel Sheet Piles	1084-2

452-3 CONSTRUCTION METHODS**(A) Sheet Pile Wall Surveys**

The plans typically show a plan view, typical sections, details, notes and an elevation or profile view (wall envelope) for each sheet pile wall. Before beginning sheet pile wall construction, survey existing ground elevations along wall face locations and other elevations in the vicinity of sheet pile wall locations as needed. Use the accepted wall envelopes for construction.

(B) Sheet Pile Installation

Install sheet piles with tolerances that meet Subarticles 450-3(B)(1) and 450-3(B)(2). Install sheet piles with the minimum required pile tip elevations in accordance with Subarticle 450-3(D).

(C) Concrete Coping

Construct concrete coping in accordance with the plans and Section 420. Do not remove forms until concrete attains a compressive strength of at least 2,400 psi. Provide a Class 2 surface finish for coping that meets Subarticle 420-17(F).

Construct coping joints at a maximum spacing of 10 ft. Make a 1/2" thick expansion joints that meet Article 420-10 for every third joint and 1/2" deep grooved contraction joints that meet Subarticle 825-10(B) for the remaining joints. Stop coping sheet pile 2" on either side of expansion joints.

(D) Backfilling and Sealing Joints

When concrete coping is required, do not backfill until concrete attains a compressive strength of at least 3,000 psi. Backfill behind sheet pile walls in accordance with Article 410-8.

Seal joints above and behind sheet pile walls between coping and ditches with joint sealer.

Section 454

1 **452-4 MEASUREMENT AND PAYMENT**

2 *Sheet Pile Retaining Walls* will be measured and paid in square feet. Sheet pile walls will be
3 measured as the square feet of exposed wall face area with the wall height equal to the
4 difference between the top and bottom of wall elevation. Define “top of wall” elevation as the
5 top of coping or top of piles for sheet pile walls without coping. Define “bottom of wall”
6 elevation as shown in the plans and no measurement will be made for portions of sheet pile
7 walls below bottom of wall elevations.

8 The contract unit price for *Sheet Pile Retaining Walls* will be full compensation for providing
9 submittals, labor, tools, equipment and sheet pile wall materials, installing sheet piles,
10 excavating, backfilling, hauling and removing excavated materials and supplying sheet piles,
11 backfill, coping and any incidentals necessary to construct sheet pile walls.

12 The contract unit price for *Sheet Pile Retaining Walls* does not include the cost for fences,
13 handrails, ditches, guardrail and barriers associated with sheet pile walls as these items will be
14 paid for elsewhere in the contract.

15 Where it is necessary to provide backfill material from sources other than excavated areas or
16 borrow sources used in connection with other work in the contract, payment for furnishing
17 and hauling such backfill material will be paid as extra work in accordance with
18 Article 104-7. Placing and compacting such backfill material is not considered extra work but
19 is incidental to the work being performed.

20 Payment will be made under:

Pay Item	Pay Unit
Sheet Pile Retaining Walls	Square Foot

21 **SECTION 454**
22 **WATERPROOFING AND DAMPPROOFING**

23 **454-1 DESCRIPTION**

24 Waterproof or dampproof concrete surfaces in accordance with these specifications for the
25 particular method of waterproofing or dampproofing called for in the plans. Furnish and
26 apply all asphalt, tar, fabric, asphalt plank and any other materials.

27 **454-2 MATERIALS**

28 Refer to Division 10.

Item	Section
Asphalt Binder	1020-7(B)
Asphalt Primer	1020-7(A)
Tar	1020-7(C)
Woven Cotton Fabric	1020-7(D)

29 **454-3 METHOD A WATERPROOFING**

30 **(A) General**

31 Method A waterproofing consists of one coat of asphalt primer, and 3 mop coats of hot
32 asphalt cement with 2 layers of cotton fabric alternating between the mop coats.

33 **(B) Preparation of Surface**

34 Ensure that concrete surfaces are dry, reasonably smooth and free from projections or
35 holes which are capable of puncturing the membrane. Immediately before applying the
36 waterproofing, thoroughly clean the surface of dust and loose materials.

37 Make sure that the concrete is at least 14 days old for Class A concrete, at least 10 days
38 old for Class AA concrete, or at least 7 days old for high early strength concrete, before

1 beginning waterproofing. Do not waterproof in wet weather nor when the temperature is
2 below 35°F, without permission.

3 **(C) Application**

4 Give waterproofed surfaces a thorough coat of asphalt primer, and allow it to set
5 thoroughly before applying the first mop coat. Heat the asphalt cement for the mop coat
6 to a temperature of at least 300°F and frequently stir to avoid local overheating. Equip
7 the heating kettles with thermometers.

8 Begin the waterproofing at the low point of the surface.

9 Use a half width first strip of fabric; and a full width second strip. Lap the full width of
10 the first strip. Make the third and each succeeding strip full width and lap so there are
11 2 layers of fabric at all points with laps at least 2" wide. Make sure that the end laps are
12 at least 12".

13 Beginning at the low point of the surface, mop a section about 20" wide and the full
14 length of the surface with hot asphalt cement. Immediately roll the first strip of fabric
15 into the asphalt cement and press into place to eliminate all air bubbles and to provide
16 a firm bond to the surface. Mop this strip and an adjacent section of the surface of
17 a width equal to slightly more than half the width of the fabric with hot asphalt binder
18 and roll a full width of the fabric into this cement, completely covering the first strip, and
19 press into place. Mop this second strip and an adjacent section of the concrete surface
20 with hot asphalt cement and place the third strip of fabric to lap the first strip at least 2".
21 Continue this process until the entire surface is covered, each strip of fabric lapping at
22 least 2" over the second preceding strip. Give the entire surface a final mopping of hot
23 asphalt cement.

24 Mop on concrete to completely cover the surface sufficiently heavy on cloth to
25 completely conceal the weave. Use at least 12 gallons of asphalt on horizontal surfaces
26 for each 100 sf of finished work and at least 15 gallons on vertical surfaces. Perform the
27 work so, at the close of a day's work, all laid cloth receives the final mopping of asphalt.
28 Thoroughly seal down all laps.

29 **(D) Special Requirements**

30 At the edges of the membrane and at any points punctured by such appurtenances as
31 drains or pipes, make suitable provisions to prevent water from getting between the
32 waterproofing and the waterproofed surface.

33 Place all membrane flashing at curbs and against girders, spandrel walls, etc., with
34 separate sheets of membrane lapping the main membrane at least 12". Closely seal
35 flashing with either a metal counter-flashing or by embedding the upper edges of the
36 flashing in a groove poured full of joint filler.

37 Provide expansion joints, both horizontal and vertical, with water stops and premolded
38 joint filler as called for in the plans. Seal expansion joints in the face adjacent to the
39 membrane bituminous material. Carry the membrane continuously across all expansion
40 joints.

41 At the ends of the structure carry the membrane well down on the abutments and make
42 suitable provisions for all movement.

43 **(E) Repairs**

44 Repair any damage that occurs as directed. Repair by patching when permitted. Extend
45 the first ply of the patch at least 12" beyond the outermost damaged portion of the
46 membrane and extend the second ply at least 3" beyond the first.

Section 460

1 **(F) Backfilling**

2 Do not backfill without permission and until the final mop coat thoroughly hardens.
3 Place backfill so the waterproofing is not damaged.

4 **454-4 METHOD B DAMPPROOFING**

5 **(A) General**

6 Method B dampproofing consists of 2 coats of tar, Grade RT 6.

7 **(B) Preparation of Surface**

8 Make sure the surfaces are dry. Immediately before applying the first dampproofing
9 coat, thoroughly clean the surfaces of dust and loose materials. Permit the concrete to
10 cure for at least 14 days for Class A concrete, at least 10 days for Class AA concrete or
11 7 days for high early strength concrete before dampproofing.

12 **(C) Application**

13 Give the concrete surfaces 2 applications tar, Grade RT 6. Apply the tar with suitable
14 brushes to secure uniform and thorough applications. Do not apply the second coat of tar
15 until the first coat thoroughly sets. Do not apply dampproofing during any time that the
16 surface is exposed to any moisture. Make sure that the temperature of the tar is such that
17 uniform and thorough application is obtained. Do not backfill until the second coat
18 thoroughly sets.

19 **454-5 MEASUREMENT AND PAYMENT**

20 *Method A Waterproofing* will be measured and paid as the actual number of square yards of
21 surface that is waterproofed. In measuring this quantity, measurement is made along the
22 actual surface that is to be waterproofed before the waterproofing is applied.

23 *Method B Dampproofing* will be measured and paid as the actual number of square yards of
24 surface that is dampproofed. In measuring this quantity, measurement is made along the
25 actual surface that is to be dampproofed before the dampproofing is applied.

26 These prices and payments will be full compensation for all items required to waterproof and
27 dampproof including, but not limited to, those items contained in Article 454-1.

28 Payment will be made under:

Pay Item	Pay Unit
Method A Waterproofing	Square Yard
Method B Dampproofing	Square Yard

29 **SECTION 460**
30 **BRIDGE RAILING**

31 **460-1 DESCRIPTION**

32 Furnish and place metal, pipe or concrete barrier bridge railing in accordance with these
33 specifications and as shown in the plans. Furnish posts, rail bars, pipe fittings, hardware,
34 paint, barrier delineators, concrete, reinforcing steel, admixtures, forms, falsework and all
35 other materials; galvanize; paint; fabricate and erect rail; and place, finish and cure concrete.

36 **460-2 MATERIALS**

37 Refer to Division 10.

Item	Section
Aluminum Rail	1074-5
Barrier Delineators	1088-2
Epoxy Coated Reinforcing Steel	1070-7

Item	Section
Galvanized Steel Rail	1074-5
Paint	1080
Pipe Rail	1074-6
Portland Cement Concrete	1000
Steel Bar Reinforcement	1070-2

1 **460-3 CONSTRUCTION METHODS**

2 Adhere to the construction load limitations of Article 420-20 while placing concrete for all
3 bridge rails.

4 **(A) Metal Rail**

5 Use either aluminum or galvanized steel rail, but use the same material on all structures
6 on the project on which metal rail is required.

7 Use shims if necessary to obtain correct post alignment.

8 Drive aluminum rivets cold. Thoroughly coat the base of aluminum rail post, closure
9 plates, shims or any other aluminum surface in contact with concrete with an approved
10 aluminum impregnated caulking compound.

11 **(B) Pipe Rail**

12 Give galvanized pipe rail one field coat of organic zinc repair paint, of minimum wet
13 thickness of 1.5 mils, after erection in accordance with Section 442 unless otherwise
14 required in the contract.

15 **(C) Concrete Barrier**

16 This subarticle applies to the construction of concrete barrier rail, vertical concrete barrier
17 rail, median barrier rail and concrete parapet, referred to collectively as concrete barrier
18 rail.

19 Plans for the concrete barrier rail are detailed for slip-formed cast-in-place concrete.
20 Unless otherwise noted, construct concrete barrier rail detailed in the plans using
21 conventional forms or by slip-forming using an approved self-propelled extrusion
22 machine. Except as noted herein, construct in accordance with Section 420.

23 Construct joints in the barrier rails at the locations and of the type shown in the plans.

24 Construct concrete barrier rail to the shape, line, grade and dimensions shown in the plans
25 except that when slip-forming rails, either radius or chamfer the corners. Check slip-
26 formed rail concrete directly behind the extrusion machine using successive overlapping
27 applications of the 10 ft straightedge. Correct high and low areas while the concrete is
28 still workable. Limit horizontal and vertical deviation from plan line and grade to no
29 more than 1/4" in 10 ft.

30 Provide sufficient internal vibrators to consolidate the concrete along the faces of forms
31 and adjacent to joints. Consolidate the concrete by internal vibration in one pass of the
32 extrusion machine. Produce a dense and homogeneous barrier free of voids and
33 honeycomb with minimum hand finishing. Coordinate concrete delivery and placement
34 to provide uniform progress while minimizing stopping and starting of the extrusion
35 machine.

36 When plans require horizontal deck drains through the barrier rails, use drain couplings
37 with slip-formed rails.

Section 462

1 Correct all exposed surfaces that are not satisfactory to the Engineer as to uniformity of
2 color and texture or because of excessive patching as required. Give the roadway face of
3 barrier rails constructed using conventional forms a Class 2 surface finish in accordance
4 with Subarticle 420-17(F). Use a broom finish on the roadway face of slip-formed
5 barrier rails.

6 Provide barrier rail delineators in accordance with Section 854.

7 **460-4 MEASUREMENT AND PAYMENT**

8 *Bar Metal Rail* will be measured and paid as the actual number of linear feet of metal
9 rail, measured along the top bar of the rail, that is completed and accepted.

10 " *Galvanized Steel Pipe Rail* will be measured and paid as the actual number of linear feet
11 of pipe rail, measured along the top pipe of the installed pipe rail, that is completed and
12 accepted.

13 *Concrete Barrier Rail* will be measured and paid as the number of linear feet of concrete
14 barrier rail provided in the plans.

15 *Vertical Concrete Barrier Rail* will be measured and paid as the number of linear feet of
16 vertical concrete barrier rail provided in the plans.

17 *Concrete Median Barrier* will be measured and paid as the number of linear feet provided in
18 the plans.

19 x *Concrete Parapet* will be measured and paid as the number of linear feet of
20 concrete parapet provided in the plans.

21 There will be no direct payment for bridge rail delineators as they are incidental to the work
22 being performed.

23 These prices and payments will be full compensation for all items required to provide bridge
24 railing including, but not limited to, those items contained in Article 460-1.

25 Payment will be made under:

Pay Item	Pay Unit
<u> </u> Bar Metal Rail	Linear Foot
<u> </u> " Galvanized Steel Pipe Rail	Linear Foot
Concrete Barrier Rail	Linear Foot
Vertical Concrete Barrier Rail	Linear Foot
Concrete Median Barrier	Linear Foot
<u> </u> x <u> </u> Concrete Parapet	Linear Foot

26

SECTION 462 SLOPE PROTECTION

27

28 **462-1 DESCRIPTION**

29 Construct slope protection under the ends of bridges or at other locations in accordance with
30 details shown in the contract. Excavate and backfill, furnish and place concrete,
31 reinforcement and other materials. Unless otherwise noted in the plans, use cast-in-place
32 reinforced concrete.

33 **462-2 MATERIALS**

34 Refer to Division 10.

Item	Section
Curing Agents	1026
Joint Fillers	1028-1
Portland Cement Concrete	1000

Item	Section
Wire Reinforcement	1070-3

1 **462-3 CONSTRUCTION METHODS**

2 Immediately before placing the paving, properly shape and firmly compact the slope so it
3 conforms to the required lines and grades.

4 Construct cast-in-place concrete slope protection in accordance with Section 420, except as
5 otherwise provided herein. Use Class B concrete. Furnish and place reinforcement as shown
6 in the plans and in accordance with Section 425. After placing the concrete for one section,
7 strike it off to plan grade and finish to a dense and uniform surface.

8 Provide a reasonably smooth and uniform surface for the finished slope protection that does
9 not vary more than 1/2" in a distance of 10 ft.

10 Do not place backfill adjacent to cast-in-place slope protection at any one end bent until each
11 individual section of paving at the end bent cures for 3 or more curing days in accordance
12 with Subarticle 420-15(A). Place backfill no later than 5 calendar days after the last section
13 of concrete paving placed at the end bent cures for 3 curing days. Compact all backfill to
14 a degree comparable to the adjacent undisturbed material.

15 **462-4 MEASUREMENT AND PAYMENT**

16 ___" *Slope Protection* will be measured and paid as the actual number of square yards of slope
17 protection, measured along the top surface of the paving, which is completed and accepted.

18 The price and payment will be full compensation for all items required to provide slope
19 protection including, but not limited to, those items contained in Article 462-1.

20 Payment will be made under:

Pay Item	Pay Unit
___" Slope Protection	Square Yard

DIVISION 5 SUBGRADE, BASES AND SHOULDERS

SECTION 500

FINE GRADING SUBGRADE, SHOULDERS AND DITCHES

500-1 DESCRIPTION

Perform the work covered by this section on all portions of the project which will be paved under the contract including, but not limited to, preparing, grading, shaping, manipulating moisture content and compacting either an unstabilized or stabilized roadbed to a condition suitable for placement of base course, pavement and shoulders. Clean, shape and maintain roadway ditches; strip existing vegetation; and place and compact in accordance with Sections 235 and 560 all materials resulting from the shaping operation. Stockpile surplus material for the construction of shoulders and dispose of any necessary surplus stockpile material as waste.

On those portions of the project where there is no pavement to be placed under the contract, perform the work of Sections 225 or 230, depending upon the source of the material. This section will not be applicable to such work.

500-2 CONSTRUCTION METHODS

(A) General

Shape the roadway to conform to the lines, grades and typical sections shown on the plans. Strip all existing vegetation from the ground surface wherever shaping of the roadway is to be done. Use all suitable surplus material in the construction of the roadway or stockpile for use in shoulder construction. Dispose of surplus material in excess of that needed for roadway or shoulder construction as waste. Obtain additional material, if needed, from roadway excavation or borrow sources.

Remove all unsuitable material, boulders and all vegetative matter and replace with suitable material. Obtain suitable material, when not available from the shaping or fine grading operation, from roadway excavation or borrow sources.

Clean, reshape and maintain roadway ditches in a satisfactory condition until final acceptance of the project. Conduct operations so as to avoid damage to any previously constructed structures and facilities.

(B) Preparation of Subgrade

Shape the subgrade to the lines, grades and typical sections shown on the plans. Where the Engineer directs that areas of the subgrade are to be stabilized with aggregate, the subgrade surface in such areas may, subject to the approval of the Engineer, be left uniformly below grade to provide for the addition of the stabilizer material.

Store or stockpile material excavated in preparing the subgrade so as to not interfere with proper drainage or later operations of stabilization, placing base or placing pavement.

(C) Compaction of Subgrade

Compact all material to a depth of 8" below the finished surface of the subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T 99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Section 500

1 Compact the subgrade at a moisture content which is approximately that required to
2 produce the maximum density indicated by the above test method. Dry or add moisture
3 to the subgrade when required to provide a uniformly compacted and acceptable
4 subgrade.

5 Where the subgrade is to be stabilized with lime, aggregate or cement, the above density
6 requirements will not apply before the incorporation of the stabilizing material; however,
7 perform compaction in accordance with Articles 501-10, 510-3 or 542-9, as appropriate.

8 **500-3 TOLERANCES**

9 A tolerance of ± 1/2" from the established grade will be permitted after the subgrade has been
10 graded to a uniform surface. Subgrade tolerance of ± 1/4" from the established grade is
11 required for subgrade under concrete pavement mainline lanes.

12 Perform the grading operation such that the maximum difference between the established
13 grade and the graded subgrade within any 100 ft section is 1/2" for normal subgrade and
14 1/4" for subgrade for concrete pavement.

15 **500-4 MAINTENANCE OF SUBGRADE**

16 Provide and maintain ditches and drains as may be necessary to drain the subgrade
17 satisfactorily. Where previously approved subgrade is damaged by natural causes, hauling
18 equipment or other traffic, restore the subgrade to the required lines, grades, typical sections
19 and density.

20 **500-5 MEASUREMENT AND PAYMENT**

21 *Fine Grading* will be paid at the contract lump sum price. Such lump sum price will be full
22 payment for all material excavated to a depth of 0.4 ft below the existing graded surface.

23 Any material which has been excavated from the subgrade at the depth greater than 0.4 ft
24 below the existing graded surface will be *Unclassified Excavation* and will be paid in
25 accordance with Article 225-7.

26 As an exception to the above, on those areas in which the Contractor is responsible for
27 constructing the embankment on which the subgrade is located, no payment will be made for
28 that excavation that may be necessary to bring the grade to the established subgrade elevation
29 and typical section. Incorporate such surplus material into the project at no additional cost to
30 the Department.

31 When sufficient material is not available from the fine grading operation to complete the work
32 of fine grading, additional material will be paid in accordance with Article 225-7 for
33 *Unclassified Excavation* or Article 230-5 for *Borrow Excavation*, depending on the source of
34 material.

35 Surplus material stockpiled for shoulder construction and incorporated into the work will be
36 paid in accordance with Article 560-4 for *Shoulder Borrow*. No payment will be made for the
37 removal and disposal of any surplus material remaining in the stockpile after the shoulders
38 have been completed.

39 Maintenance, repair and restoration of the subgrade to the required lines, grades, typical
40 sections and density as it applies to fine grading is incidental to the work of this section.

41 Payment will be made under:

Pay Item
Fine Grading

Pay Unit
Lump Sum

**SECTION 501
LIME-TREATED SOIL**

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501-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, treating the subgrade, embankment, natural ground or existing pavement structure by adding water and lime in the form specified herein, mixing, shaping, compacting and finishing the mixture to the required density. Prepare the soil layer to be stabilized; haul, proportion, spread and mix the materials within the depth range as shown on plans; manipulate, compact and finish the lime-treated soil; correct, repair and maintain the lime-treated soil; and apply a sand seal in accordance with the requirements of Article 501-3. Construct the work in accordance with the typical sections, lines and grades shown on the plan.

501-2 MATERIALS

Refer to Division 10.

Item	Section
Lime	1052-3
Water	1024-4

Use soil material which consists of material upon which the pavement is to be placed, existing material upon which the embankment is to be placed, approved borrow material or a combination of these materials proportioned as directed. Remove all vegetation, roots or other objectionable matter from the soil, as well as all aggregate or stone larger than 2" for the full depth to be treated.

501-3 LIMITATIONS

Do not perform lime stabilization when the air temperature is below 45°F. Do not mix the lime with frozen soils or when the soils contain frost. Apply lime to such areas as can be initially mixed and sealed during the day of application. Do not apply lime when wind conditions are such that blowing lime becomes hazardous to traffic, workers or adjacent property owners or when excessive loss of lime may occur.

Do not construct lime-treated soil that will not be covered with a layer of pavement or base by December 1 of that same calendar year. The Engineer may suspend the lime stabilization operations in writing when he determines that the Contractor will not cover the completed stabilization by December 1 as specified above.

Failure of the Contractor to cover the lime-treated soil as required will result in the Engineer notifying the Contractor in writing to cover the lime-treated soil with a sand seal. Apply the sand seal in accordance with Section 660, except Articles 660-3 and 660-11 will not apply. If the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have such work performed by other forces and equipment. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged stabilization, no matter what the cause of damage, at no cost to the Department.

501-4 EQUIPMENT**(A) General**

Use any combination of machines and equipment to produce the required results that meet the approval of the Engineer. Correct any leakage of fluids or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Comply with Article 107-21 with respect to operation of equipment and prevent damage to the base while applying water, curing seal and blotting sand.

Section 501

1 (B) Lime Spreaders

2 Spread lime at the required rate by methods and equipment, which have been approved.

3 (C) Water Distribution Equipment

4 Add water to the soil with a pressure distributor or other suitable equipment capable of
5 uniformly distributing the required amount.

6 (D) Mixers

7 Perform mixing with a self-propelled rotary mixer, except that disc harrows, motor
8 graders and other equipment may be used only to supplement the mixing done by the
9 rotary mixer.

10 Use mixing equipment capable of mixing to a compacted depth of at least 10".

11 (E) Compaction Equipment

12 Use compaction equipment that is self-propelled. Perform finish rolling with
13 a pneumatic tired roller, or as permitted, a smooth, steel-wheel roller or a combination of
14 both types.

15 (F) Scarifying Equipment

16 Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of
17 scarifying to the full depth of the stabilized treatment. When required, use a weeder,
18 spiketooth harrow or nail drag, followed by a broom drag to scarify during finishing
19 operations.

20 501-5 PROTECTION AND SAFETY

21 Take necessary precautions to protect personnel from dust created by the lime application and
22 mixing operation to include eye protection, dust masks and appropriate training.

23 501-6 PREPARATION OF ROADBED

24 Before the addition of any lime to the soil, grade and shape the area to be stabilized in
25 accordance with the typical sections, lines and grades shown on the plans. Remove all
26 materials such as aggregate larger than 2", roots and turf.

27 501-7 SCARIFYING

28 When required by the method of application, scarify the soil to the required depth and width
29 and then partially pulverize by making one pass through the area with a pulverizing rotary
30 mixer. Delete the pulverizing portion of the scarifying operation in areas where the soil types
31 or conditions make pulverizing with a rotary mixer impractical.

32 501-8 APPLICATION OF LIME

33 (A) General

34 When the Contractor has brought the soil layer to the elevation required by the plans, the
35 Engineer will sample the soil and determine the quantity of lime to be incorporated.
36 Allow 24 calendar days for the Engineer to perform the required sampling, testing and
37 final design of the lime stabilization. The optimum moisture will be determined by the
38 Engineer.

39 Spread lime or lime slurry only on an area of such size that all primary mixing operations
40 can be completed in the same day during daylight hours, except where the work is to be
41 done at night as required by the contract.

42 Incorporate the lime or lime slurry into the soil mixture at the rates determined by the
43 Engineer. Distribute the lime at the uniform rate and minimize the scattering by the
44 wind. Mix the lime into the soil within 2 hours after application.

1 No equipment, except that used in spreading, slaking and mixing, will be allowed to pass
2 over the freshly spread lime until it is mixed with the soil.

3 **(B) Slurry Method**

4 Do not add lime slurry to the soil when the moisture content exceeds 2% above optimum
5 moisture. Aerate soil or allow to dry naturally until the soil contains no more than
6 2% above optimum moisture.

7 Mix hydrated lime applied by this method with water in approved agitating equipment
8 and apply to the soil to be treated as a thin water suspension or slurry. When quicklime is
9 used to produce the slurry, use equipment specifically manufactured for the slaking of
10 quicklime. Use distributing equipment that provides continuous agitation of the slurry
11 from the slurry production site until the slurry is applied to the soil. Proportion the lime
12 so that the dry solids content is at least 30% by weight.

13 Split the lime application into approximately 2 equal applications with the first being
14 partially mixed into the soil to a minimum depth of 3" before applying the second
15 application.

16 **(C) Quicklime**

17 Do not add dry quicklime to the soil when the moisture content exceeds 4% above
18 optimum moisture. Aerate soil or allow to dry naturally until it contains no more than
19 4% above optimum moisture.

20 Where the "Bottom-Dump" method of application is used, omit the preliminary
21 scarification of the soil surface. Apply the quicklime by slowly driving the tanker truck
22 over the coverage area with the bottom discharge valves open creating a windrow of
23 quicklime.

24 Repeat the process until the tanker is empty in order to provide at least 3, for a 24 ft
25 roadway, reasonably uniform and equally spaced windrows over the area being
26 stabilized. The number of windrows required will depend on the width of the section
27 being stabilized and will be stipulated by the Engineer.

28 Carefully spread the windrows of quicklime with a motor grader into an equal depth layer
29 over the entire area to be stabilized.

30 After the lime has been spread, follow with a sprinkling of water to slake the lime. After
31 a complete slaking of the lime, thoroughly mix the lime with the soil. The Engineer may
32 direct that the lime first be mixed into the soil followed by sprinkling and additional
33 mixing to ensure complete slaking of the lime throughout the layer to be stabilized.

34 **(D) Hydrated Lime**

35 Use hydrated lime only with written permission and do not add to the soil when the
36 moisture content exceeds 6% above optimum moisture.

37 **501-9 MIXING**

38 **(A) Primary Mixing**

39 Immediately after the lime has been spread and slaked, if required, mix the lime into the
40 soil for the full depth of treatment. Mix the lime into the soil to provide a compacted
41 depth of at least 8". A minimum number of mixing passes will be required to ensure
42 uniform incorporation of the lime. Add water as necessary and thoroughly mix with the
43 soil lime mixture so that the mixture contains no less than optimum moisture.
44 A tolerance of 3% above optimum will be allowed. Incorporate all of the lime
45 thoroughly and uniformly into the soil layer to the full depth of treatment so that the
46 result is a homogeneous, friable mixture of soil and lime, free of clods or lumps
47 exceeding 2" in size.

Section 501

1 After primary mixing operations and before curing, shape and lightly compact the lime-
2 treated area to the approximate section to allow for proper drainage and to minimize
3 evaporation loss.

4 (B) Preliminary Curing

5 Following primary mixing operations, cure the stabilized layer for 1 to 4 days. The
6 actual duration of this curing period will be determined by the Engineer. During the
7 curing period, keep the surface of the material moist to prevent drying and cracking and
8 maintain in a properly sealed and crowned condition. Mix, compact, shape and finish the
9 stabilized layer no later than 4 days after primary mixing.

10 (C) Final Mixing and Pulverizing

11 Immediately after the completion of the preliminary curing period, mix and pulverize
12 completely the stabilized layer to the full depth of the stabilization. Continue the final
13 mixing until all of the clods are broken down to pass a 1/2" sieve and at least 80% pass
14 a No. 4 sieve, exclusive of rock. Add water, as required, during the final mixing to raise
15 the moisture content before compaction.

16 501-10 COMPACTING, SHAPING AND FINISHING

17 Begin compaction of the mixture immediately after completion of the final mixing operations.
18 Aerate or moisten the mixture as necessary during compaction operations to maintain the
19 moisture between optimum and optimum plus 2%. Compact the full depth of the mixture to
20 a density equal to at least 97% of that obtained by compacting a sample of the soil lime
21 mixture in accordance with AASHTO T 99 as modified by the Department. Copies of these
22 modified procedures are available upon request from Materials and Tests Unit. Accompany
23 the compaction with sufficient blading to eliminate irregularities.

24 Perform the final rolling of the completed surface with a pneumatic-tired roller or if permitted
25 a smooth, steel-wheel roller.

26 Complete shaping, final mixing, compacting and finishing on the same day upon completion
27 of the preliminary curing. This work is to be completed no later than 4 days after primary
28 mixing and done during daylight hours, unless otherwise provided in the contract. If the
29 above work is not completed as specified, rip up the entire section and add additional lime, as
30 directed, at no additional cost to the Department.

31 501-11 THICKNESS

32 The compacted thickness of the completed treated soil layer will be determined by
33 measurements made in test holes located at random intervals not to exceed 500 ft. Do not
34 deviate the measured thickness from that shown on the plans by more than plus 1" or
35 minus 1/2".

36 Where the lime-treated soil layer is deficient in thickness by more than 1/2", remove and
37 replace the area of deficient thickness with lime-treated soil having the required thickness at
38 no cost to the Department.

39 As an exception to the above, if the deficiency is not considered sufficient to seriously impair
40 the required strength of the lime-treated soil layer, the deficient area may, at the discretion of
41 the Engineer, be left in place.

42 501-12 FINAL CURING

43 After the lime-treated soil has been finished in accordance with Article 501-10, protect it
44 against drying for a 7 day curing period in accordance with Section 543.

1 **501-13 TRAFFIC**

2 Completed sections of the lime-treated soil may be opened when necessary to lightweight
 3 local traffic, provided it has hardened sufficiently to prevent marring or distorting of the
 4 surface and provided the curing is not impaired. Do not use construction equipment on the
 5 lime-treated soil, except as necessary to discharge material into the spreader during paving
 6 operations or except as may be otherwise permitted for embankment construction.

7 **501-14 MAINTENANCE**

8 Maintain the lime-treated soil in an acceptable condition until final acceptance of the project.
 9 Include immediate repair of any defects or damage in maintenance operations. Repeat as
 10 necessary to keep the lime-treated soil in an acceptable condition. Perform repairs to
 11 lime-treated soil by replacing the lime-treated soil for its full depth rather than by adding
 12 a thin layer of lime stabilized material to the existing layer. An alternate repair method may
 13 be used if approved in writing.

14 **501-15 MEASUREMENT AND PAYMENT**

15 *Lime-Treated Soil* will be measured and paid as the number of square yards of each layer of
 16 lime-treated soil that has been completed and accepted. In determining this quantity, the
 17 width of the lime-treated soil will be measured across the top surface of the treated layer. The
 18 length will be the actual length constructed, measured along the centerline of the surface of
 19 the treated layer.

20 *Lime for Lime-Treated Soil* where hydrated lime or quick lime is spread directly on the soil in
 21 solid form or when hydrated lime is used to produce a slurry, the quantity of lime to be paid
 22 will be the number of tons of lime that has been incorporated into the soil at the required rates.
 23 No measurement will be made of any lime added or replaced for corrective measures during
 24 construction or for repairing damaged areas. Measurement is to be made in bulk in the truck
 25 on certified platform scales or other certified weighting devices.

26 Where quicklime is slaked on the project and applied in slurry form, measurement will be
 27 calculated as indicated below for each truckload using the certified lime purity for that load.

$$A+B = \text{Total hydrated lime produced (pay quantity)}$$

Where:

$$A = \text{Certified weight of quicklime delivered} \times \% \text{ purity} \times 1.32$$

$$B = \text{Certified weight of quicklime delivered} \times \% \text{ inert material}$$

28 *Asphalt Curing Seal* will be paid in accordance with Article 543-5.

29 *Blotting Sand* will be paid in accordance with Article 818-4.

30 If a layer of lime-treated soil is deficient in thickness but has been permitted to be left in place
 31 in accordance with Article 501-11, payment for that lime-treated soil and lime will be made at
 32 50% of the contract unit prices for *Lime-Treated Soil* and *Lime for Lime-Treated Soil*.

33 Sand seal applied due to the failure of the Contractor to cover the lime-treated soil as required
 34 will be incidental to the work of this section. If the Contractor fails to provide sand seal as
 35 required and the Engineer has the work performed by other forces, the cost of such work will
 36 be deducted from monies due or to become due to the Contractor.

37 Maintenance, repair and restoration of the lime stabilization is incidental to the work of this
 38 section.

39 Payment will be made under:

Pay Item	Pay Unit
Lime-Treated Soil	Square Yard
Lime for Lime-Treated Soil	Ton

Section 505

**SECTION 505
AGGREGATE SUBGRADE**

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505-1 DESCRIPTION

Construct aggregate subgrades in accordance with the contract or as directed. Undercut as needed in cut areas. Install geotextile for soil stabilization and place Class IV subgrade stabilization at locations shown on the plans.

505-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Soil Stabilization, Type 4	1056
Select Material, Class IV	1016

Use Class IV select material for Class IV subgrade stabilization.

505-3 CONSTRUCTION METHODS

When shallow undercut is required to construct aggregate subgrades, undercut 6" to 24" as shown on the plans or as directed. Perform undercut excavation in accordance with Section 225. Install geotextile for soil stabilization in accordance with Article 270-3. Place Class IV subgrade stabilization (standard size no. ABC) by end dumping ABC on geotextiles. Do not operate heavy equipment on geotextiles until geotextiles are covered with Class IV subgrade stabilization. Compact ABC to 92% of AASHTO T 180 as modified by the Department or to the highest density that can be reasonably obtained.

Maintain Class IV subgrade stabilization in an acceptable condition and minimize the use of heavy equipment on ABC in order to avoid damaging aggregate subgrades. Provide and maintain drainage ditches and drains as required to prevent entrapping water in aggregate subgrades.

505-4 MEASUREMENT AND PAYMENT

Shallow Undercut will be measured and paid in cubic yards. Shallow undercut will be measured in accordance with Article 225-7. The contract unit price for *Shallow Undercut* will be full compensation for excavating, hauling and disposing of materials to construct aggregate subgrades.

Class IV Subgrade Stabilization will be measured and paid in tons. Class IV subgrade stabilization will be measured by weighing material in trucks in accordance with Article 106-7. The contract unit price for *Class IV Subgrade Stabilization* will be full compensation for furnishing, hauling, handling, placing, compacting and maintaining ABC.

Geotextile for Soil Stabilization will be measured and paid in accordance with Article 270-4.

Payment will be made under:

Pay Item	Pay Unit
Shallow Undercut	Cubic Yard
Class IV Subgrade Stabilization	Ton

SECTION 510
AGGREGATE STABILIZATION

510-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing all aggregate and water; hauling, spreading and mixing the required amount of aggregate with the subgrade materials; shaping and compacting the stabilized subgrade to the required grade and typical section; and maintaining the aggregate.

510-2 MATERIALS

Refer to Division 10.

Item	Section
Stabilizer Aggregate	1008-1

510-3 CONSTRUCTION METHODS**(A) Mixing**

Remove sufficient subgrade material, if necessary, to compensate for the addition of the stabilizer aggregate. Spread the quantity of aggregate required by the contract uniformly over the subgrade by means of a mechanical spreader. Spread the aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Mix the aggregate with the top 3" of the subgrade soil. Continue mixing until the aggregate is uniformly mixed with the soil to the width and depth to be treated.

The aggregate shall be sampled, tested and approved before placing layers of base material or pavement thereon.

(B) Shaping and Compaction

Shape the stabilized subgrade to the lines, grades and typical sections shown on the plans.

Compact the entire depth and width of the stabilized subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T 99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. Compact the stabilized subgrade at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. Dry or add moisture to the material as required to provide a uniformly compacted and acceptable subgrade.

510-4 TOLERANCE

A tolerance of $\pm 1/2$ " from the established grade will be permitted after the stabilized subgrade has been graded to a uniform surface.

Perform grading of the subgrade such that the maximum differential between the established grade and the stabilized subgrade within any 100 ft distance is $1/2$ ".

510-5 PROTECTION

Protect the aggregate stabilized subgrade in accordance with Article 500-4.

510-6 MEASUREMENT AND PAYMENT

Stabilizer aggregate will be measured and paid as the actual number of tons of aggregate, exclusive of any corrective material, which has been mixed with the completed and accepted subgrade. This quantity will be measured as provided for in Article 520-11.

Section 520

1 Payment will be made under:

Pay Item
Stabilizer Aggregate

Pay Unit
Ton

2
3

SECTION 520
AGGREGATE BASE COURSE

4 **520-1 DESCRIPTION**

5 Perform the work covered by this section including, but not limited to, constructing a base
6 composed of an approved aggregate material hauled to the road, placed on the road, mixed,
7 compacted and shaped in accordance with the lines, grades, depths and typical sections shown
8 in the plans; applying a sand seal in accordance with Article 520-5; and maintaining the base.

9 **520-2 MATERIALS**

10 Refer to Division 10.

Item
Aggregate Base Course

Section
1006 and 1010

11 **520-3 METHODS OF PRODUCTION**

12 Furnish aggregate upon which no restrictions are placed on the production or stockpiling,
13 except as provided in Sections 1005, 1006 and 1010. Place aggregates on the roadway which
14 have been sampled, tested and approved in accordance with Article 520-6.

15 **520-4 SUBGRADE PREPARATION**

16 Prepare the subgrade in accordance with Section 500 before placement of the base material.

17 **520-5 HAULING AND PLACING AGGREGATE BASE MATERIAL**

18 Place the aggregate material on the subgrade with a mechanical spreader capable of placing
19 the material to a uniform loose depth and without segregation; except, for areas inaccessible
20 to a mechanical spreader, the aggregate material may be placed by other methods approved by
21 the Engineer.

22 Where the Contractor elects to use more than one source of aggregate as described in
23 Section 1005, place the various types of aggregate used in an approved manner which will
24 permit the sampling and testing required by Section 1006 and 1010.

25 Where the required compacted thickness of base is 10" or less, the base material may be
26 spread and compacted in one layer. Where the required compacted thickness is more than
27 10" spread the base material and compact in 2 or more approximately equal layers. Compact
28 the base material to a minimum thickness of approximately 4" for any one layer.

29 Have each layer of material sampled, tested, compacted and approved before placing
30 succeeding layers of base material or pavement.

31 Do not place base material on frozen subgrade or base.

32 Base course that is in place on November 15 shall immediately be covered with a subsequent
33 layer of pavement structure or with a sand seal. Base course that has been placed between
34 November 16 and March 15 inclusive shall be covered within 7 calendar days with
35 a subsequent layer of pavement structure or with a sand seal. Apply sand seal in accordance
36 with Section 660, except Articles 660-3 and 660-11 will not apply.

37 Failure by the Contractor to cover the base course as required above will result in the
38 Engineer notifying the Contractor in writing to cover the base course with a sand seal and to
39 suspend the operations of placing aggregate base course until such cover has been placed. If
40 the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the
41 Engineer may proceed to have such work performed with other forces and equipment.

1 The application of the sand seal by the Contractor or by others will in no way relieve the
2 Contractor of the responsibility to maintain or repair the damaged base or subgrade, no matter
3 what the cause of damage.

4 Do not allow traffic on the completed base course other than necessary local traffic and that
5 developing from the operation of essential construction equipment as may be authorized by
6 the Engineer. Repair any defects that develop in the completed base or any damage caused by
7 local or construction traffic acceptably. Hauling equipment may be operated with the
8 approval of the Engineer, over a lower layer of base, however, acceptably repair any rutting,
9 weaving or soft areas that develop.

10 Do not exceed 35 mph with hauling equipment traveling over any part of the base.

11 Use methods of handling, hauling and placing which will minimize segregation and
12 contamination. If segregation occurs, the Engineer may require that changes to the
13 Contractor's methods and may require mixing on the road to correct segregation. Remove and
14 replace all aggregate which is contaminated with foreign materials to the extent that the base
15 course will not adequately serve its intended use. The above requirements will be applicable
16 regardless of the type of aggregate placed and regardless of prior acceptance.

17 **520-6 SAMPLING, TESTING AND ACCEPTANCE**

18 Perform sampling for the determination of gradation, LL and PI for the various types of
19 aggregate, as defined in Articles 1010-1 and 1010-2.

20 Where visual observation indicates the need to do so, the Engineer may require the Contractor
21 to road mix areas of nonuniform gradation. The Engineer reserves the right to take samples in
22 addition to the lot acceptance samples from within the lot in areas exhibiting nonuniform
23 gradation. When the test results from such an additional sample is outside the gradation limits
24 in Section 1010 and the nonuniformity cannot be corrected by road mixing, the aggregate base
25 course represented by the sample will be rejected and replaced by the Contractor.

26 **520-7 SHAPING AND COMPACTION**

27 Machine and compact the layer of base within 48 hours after beginning the placing of a layer
28 of the base. Maintain each layer to the required cross section during compaction and compact
29 each layer to the required density before placing the next layer.

30 When electing to use conventional density test number 3 (ring test) to determine density,
31 compact each layer of the base to a density equal to at least 100% of that obtained by
32 compacting a sample of the material in accordance with AASHTO T 180 as modified by the
33 Department. Copies of these modified testing procedures are available upon request from the
34 Materials and Tests Unit.

35 Follow the requirements as specified in Article 520-9 when electing to use nuclear methods to
36 determine the density.

37 Compact the base material at a moisture content which is approximately that required to
38 produce a maximum density indicated by the above test method. Dry or add moisture to the
39 material when required to provide a uniformly compacted and acceptable base.

40 Shape the final layer of base material in accordance with the lines, grades and typical section
41 as shown on the plans. Construct the base course so that it is smooth, hard, dense, unyielding
42 and well bonded upon completion. A broom drag may be used in connection with the final
43 finishing and conditioning of the surface of the base course.

44 **520-8 TOLERANCES**

45 After final shaping and compacting of the base, the Engineer will check the surface of the
46 base for conformance to the grade and typical section and determine the base thickness.

Section 520

1 Construct the base so that the thickness of the base is within a tolerance of $\pm 1/2$ " of the base
2 thickness required by the plans. When the base course will be used under concrete pavement,
3 the tolerance will be $\pm 1/4$ ".

4 Construct the base so that the maximum differential between the established grade and the
5 base within any 100 ft section is $1/2$ " or $1/4$ " when used as a base course under concrete
6 pavement.

7 **520-9 DENSITY DETERMINATION BY NUCLEAR METHODS**

8 **(A) Application**

9 The Engineer may use nuclear means as described below to determine the density of
10 selected base course materials required by Sections 520 and 540. The target density will
11 be from the material's most recent AASHTO T 180 test results, which may be obtained
12 from the Materials and Tests Unit.

13 A new target density is to be obtained when there is a change in the source of material,
14 when a significant change occurs in the composition of the materials from the same
15 source or when determined necessary.

16 Testing will be performed in the direct transmission mode on all aggregate base course.
17 Additional information on testing is provided in the *NCDOT Nuclear Gauge Operator's*
18 *Manual*, copies of which are available from the Materials and Tests Unit.

19 **(B) Test Sections**

20 (1) General

21 Provide a test section which has a depth no greater than the layer depth shown in the
22 plans or required by the *Standard Specifications*, whichever is less. Determine the
23 length of the section by the width as shown in the *NCDOT Nuclear Gauge*
24 *Operator's Manual*.

25 In situations where the chemical composition of the material affects the gauge
26 moisture readings, the Materials and Tests Unit will provide specific instructions.

27 (2) Equipment

28 Equipment used in the compaction of test sections shall be approved before use.
29 Where uniform density is not being obtained throughout the depth of the layer of
30 material being tested, change the type and/or weight of the compaction equipment as
31 necessary to achieve uniform density even though such equipment has been
32 previously approved.

33 When aggregate base course material is involved, use at least one steel-wheel
34 vibratory roller weighing at least 6 tons.

35 (3) Compaction

36 After the material in a test section has been spread and shaped to the required width
37 and depth, begin the compaction of the section. Carry out compaction to obtain
38 uniform maximum density over the entire test section.

39 Immediately before compacting the aggregate base course material, make sure it has
40 satisfactory moisture content. If it is necessary to add water after the material is
41 placed, scarify the material and add water uniformly throughout the full depth of the
42 layer of the base course material.

1 (4) Testing Procedures

2 After the Contractor has completed compaction of the test section, the Engineer will
 3 conduct 5 density tests at random within 5 equal segments of the test section.
 4 Provide a smooth surface on the material being tested before any tests being
 5 performed. Density tests will not be made when the surface of an aggregate base
 6 course contains free moisture. The required density will be expressed as
 7 a percentage of the target density.

8 (5) Acceptance Requirements

9 Provide a density for aggregate base course of at least 98% of the nuclear target
 10 density. In addition, the nuclear density of any single test location shall be at least
 11 95% of the nuclear target density.

12 The required density will be determined by the average of 5 nuclear density tests
 13 made at random locations within 5 equal segments of the test sections.

14 **520-10 MAINTENANCE**

15 Where the base material is placed in a trench section, provide adequate drainage through the
 16 shoulders to protect the subgrade and base until such time as the shoulders are completed.

17 Maintain the surface of the base by watering, machining, rolling or dragging when necessary
 18 to prevent damage to the base by weather or traffic.

19 Where the base or subgrade is damaged, repair the damaged area; reshape the base to required
 20 lines, grades and typical sections; and recompact the base to the required density at no cost to
 21 the Department.

22 **520-11 MEASUREMENT AND PAYMENT**

23 *Aggregate Base Course* will be measured and paid at the contract unit price per ton for the
 24 actual number of tons of aggregate which has been incorporated into the completed and
 25 accepted work. Sampling and acceptance will be determined in accordance with
 26 Section 1010.

27 The aggregate will be measured by being weighed in trucks on certified platform scales or
 28 other certified weighing devices. If permitted by the contract, the weight of base course
 29 material shipped by barge may be determined from water displacement measurements.

30 No deductions will be made for any moisture contained in the aggregate at the time of
 31 weighing.

32 Sand seal applied due to the failure of the Contractor to cover the base course as required will
 33 be incidental to the work of this section. If the Contractor fails to provide sand seal as
 34 required and the Engineer has the work performed by other forces, the cost of such work will
 35 be deducted from monies due or to become due to the Contractor.

36 Maintenance, repair and restoration of the base course and subgrade is incidental to the work
 37 of this section. If segregation during handling, hauling or placing occurs and the Engineer
 38 requires a change in methods or mixing on the road to correct this segregation, this work will
 39 be incidental to the work of this section. Removal and replacement of aggregate which is
 40 contaminated with foreign materials or outside the gradation limits will be incidental to the
 41 work of this section.

42 Payment will be made under:

Pay Item	Pay Unit
Aggregate Base Course	Ton

Section 535

**SECTION 535
CONDITIONING EXISTING BASE**

535-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, scarifying, shaping, furnishing water, compacting and maintaining the base. Included in the work is:

(A) Conditioning of an existing base to prepare it for the placement of a pavement directly upon the base. Included in the conditioning is scarifying, shaping and compacting the base to conform to the required lines, grades, depths and typical sections established by the plans.

(B) Conditioning of an existing base in preparation for the placement of additional layers of base material. Included in the conditioning is scarifying, shaping and compacting the base to conform to the approximate lines, grades, depths and typical sections established by the plans.

535-2 CONSTRUCTION METHODS

Compact the base to a degree satisfactory to the Engineer. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

Do not condition the existing base when it contains excess moisture or is frozen.

Maintain the base in accordance with Article 520-10.

535-3 MEASUREMENT AND PAYMENT

Conditioning Existing Base will be measured and paid at the contract unit price per 1,000 sy for the actual number of units of 1,000 sy of base over which the work of conditioning existing base has been acceptably performed. The length will be measured along the centerline of the surface of the base. The width will be the width required by the plans or established by the Engineer measured across the top surface of the base.

Payment will be made under:

Pay Item	Pay Unit
Conditioning Existing Base	1,000 Square Yards

**SECTION 540
CEMENT-TREATED BASE COURSE**

540-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, construction and curing a cement-treated base composed of aggregate, furnishing of water and aggregate; the mixing, proportioning, hauling and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 540-3. Compact, shape and cure the base to conform to the lines, grades, depths and typical sections shown on the plans.

When cement-treated base course is called for on the plans, the Contractor has the option of providing a plant mixed cement-treated base course or a road mixed cement-treated base course as specified below.

540-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate	1010-1, 1010-2

Item	Section
Portland Cement, Type I	1024-1
Water	1024-4

1 **540-3 LIMITATIONS**

2 Do not construct cement-treated base when the air temperature is less than 40°F nor when
3 conditions indicate that the temperature may fall below 40°F within 24 hours. Do not
4 incorporate frozen materials into the mixture nor place material on frozen subgrade. Protect
5 the base from freezing for 7 days after completion.

6 Do not place cement-treated base that will not be covered with pavement by December 1 of
7 the same year. Failure of the Contractor to cover the cement-treated base as required above
8 will result in the Engineer notifying the Contractor in writing to cover the cement-treated base
9 with a sand seal. Apply the sand seal in accordance with Section 660, except Articles 660-3
10 and 660-11 will not apply. If the Contractor fails to apply the sand seal within 72 hours after
11 receipt of such notice, the Engineer may proceed to have the work performed with other
12 forces and equipment. The application of the sand seal by the Contractor or other forces will
13 in no way relieve the Contractor of the responsibility to maintain or repair the damaged base,
14 no matter what the cause of damage.

15 **540-4 PREPARATION OF SUBGRADE**

16 Prepare the subgrade in accordance with Section 500. Prepare the subgrade so that it is firm
17 and able to support without displacement the construction equipment and the compaction
18 operations hereinafter specified. Soft or yielding subgrade shall be corrected and made stable
19 before construction proceeds. Moisten the subgrade as needed before spreading the base
20 material.

21 **540-5 CONSTRUCTION METHODS**

22 **(A) Composition of Mixture**

23 When the Contractor proposes to use a source of aggregate that is not documented by
24 a currently approved job mix formula, submit to the Department's Materials and Tests
25 Unit, samples of all aggregates proposed for use at least 3 weeks before beginning
26 production. Take the aggregate samples in the presence of the Engineer. Submit in
27 writing the proposed gradation for the cement-treated base material. The Department
28 will then prepare a mix design based upon the samples submitted and the Contractor's
29 stated proposed gradation.

30 A job mix formula will be established for the cement-treated base material within the
31 design limits in Section 1010. Use the job mix formula unless modified in writing by the
32 Engineer.

33 Prepare all cement-treated base material mixtures so that they conform to the job mix
34 formula within the tolerance ranges specified in Table 540-1. If the Contractor is unable
35 to maintain the production within the tolerance ranges specified in Table 540-1,
36 production will stop until such time as a new mix design and job mix formula has been
37 established and approved by the Engineer.

**TABLE 540-1
TOLERANCES
FOR JOB MIX FORMULA
PORTLAND CEMENT-TREATED BASE**

Sieve Size	Tolerance for Percent Passing
1 1/2"	0
1"	± 5
1/2"	± 8
No. 4	± 7
No. 10	± 7
No. 40	± 4
No. 200	± 2
Material Passing No. 10 Sieve(Soil Mortar)	
No. 40	± 8
No. 200	± 5

1 **(B) Plant Mixed Cement-Treated Base Course**

2 (1) Mixing

3 (a) General

4 Add to the aggregate the quantity of cement specified by the Engineer.

5 Thoroughly mix the cement, aggregates and water in an approved central mixing
6 plant. Use a batch or continuous-flow type stationary mixer and equip it with
7 feeding and metering devices that will add aggregate, cement and water into the
8 mixer in the specified quantity. Use batch weights or rates of feed of cement
9 that are within 0.3% of the quantity designated by the Engineer. Use batch
10 weights or rates of flow of water that are within a range of optimum to optimum
11 plus 1.5% moisture. Use batch weights or rates of feed of aggregate that are
12 within 5% of the amounts designated by the Engineer.

13 Mix materials at least 20 seconds to assure a proper blend of materials.

14 (b) Batch Type Plant

15 Equip the mixer with a sufficient number of paddles of a type and arrangement
16 to produce a uniformly mixed batch.

17 Add water during the mixing operation as required to provide the quantity of
18 moisture specified; however, do not add water to the mixture before the
19 aggregate and cement have been mixed sufficiently to prevent the formation of
20 cement balls.

21 Equip the mixer with a timing device which will indicate by a definite audible or
22 visual signal the expiration of the mixing period.

23 (c) Continuous Flow Type Plant

24 Calibrate and mark cement storage silos so that the amount of cement in the silo
25 can be readily determined at any time. Design feeders and/or meters for
26 introducing the cement into the mixer such that the amount of cement can be
27 accurately determined before it is introduced into the mixer. Use a variable
28 speed motor on the cement feeder which is regulated by a control mechanism
29 indicating the speed of the motor in r.p.m. or equivalent measure. Design the
30 indicator so that it can be read in daylight from a point 4 ft from the indicator.
31 Equip the cement holding tank which is used in feeding cement with an air
32 pressure gauge and air pressure regulating control such that air pressure can be
33 regulated to a uniform flow.

1 Measure the water by a meter which determines flow in gallons per minute and
 2 control it with 2 valves. Use a variable flow valve for controlling the rate of
 3 flow of the water only on one valve and use an on-off valve connected to the
 4 plant controls such that the water is turned on and/or off when the plant is
 5 started and stopped for the other valve.

6 After the material has been processed by the pug mill, store it in a holding bin
 7 with the minimum capacity of 3 tons before discharging into trucks. Hold the
 8 material in the holding bin for loading purposes only and do not store for
 9 loading subsequent trucks. Loading trucks directly from a belt or auger box will
 10 not be permitted.

11 Have available a satisfactory platform for obtaining samples from trucks. Make
 12 provisions for calibrating the plant daily and at other times as deemed necessary
 13 by the Engineer. On plants that are electronically controlled, manual calibration
 14 will be required to verify the electronic calibration and shall be performed at the
 15 beginning of a project. If the plant operation is interrupted by more than
 16 4 calendar days during an active project, perform the manual calibration process
 17 again. Perform random manual calibrations at the direction of the Engineer.

18 (2) Hauling and Placing

19 Haul the mixed base material to the roadway in trucks with protective covers to
 20 avoid moisture loss. Do not exceed one hour between the loading of the haul trucks
 21 and the beginning of compaction.

22 Place stringlines for alignment control for placing a layer of base.

23 Place the base in a uniform layer on the moistened, prepared subgrade to produce the
 24 depth required by the plans. To insure homogenous distribution of the base material
 25 in each layer, place the material using approved spreaders. Perform the spreading
 26 operations to eliminate pockets of material of non-uniform gradation resulting from
 27 segregation in the hauling or discharging operations. Spread each layer so that
 28 compaction can be started without further shaping.

29 A single spreader may be used provided it is capable of placing a uniform, full-depth
 30 layer of material across the full width of the base in one pass. Otherwise, 2 or more
 31 spreaders will be required and operate the spreaders so that the spreading progresses
 32 along the full width of the base in a uniform manner.

33 Base placed on areas inaccessible to mechanical spreading equipment may be spread
 34 in one layer by approved methods. After spreading, compact the material thoroughly
 35 to the required lines, grades and typical sections by means of pneumatic tampers or
 36 with other compaction equipment which will constantly obtain the degree of
 37 compaction required.

38 (C) Road Mixed Cement-Treated Base Course

39 (1) Equipment

40 Use any combination of machines or equipment that will produce the required results
 41 meeting the approval of the Engineer. Use a cement spreader which has
 42 an adjustable rate of flow and the capability of spreading the required amount of
 43 cement in one pass. Mix cement, aggregate and water with a self-propelled rotary
 44 mixer capable of mixing to a depth of 10". Correct any leakage of fluids and/or
 45 materials promptly or the Engineer may order such equipment removed and replaced
 46 with satisfactory equipment. Use equipment and methods for applying cement,
 47 water, curing seal and blotting sand that does not damage the base and in accordance
 48 with Article 107-21.

Section 540

(2) Spreading and Mixing

Place the required quantity of aggregate on the prepared subgrade in a uniform layer. Spread aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Apply the required quantity of cement in a uniform spread on the aggregate in place and immediately blend the aggregate until the cement is uniformly distributed throughout the aggregate. Maintain the moisture content at or below the optimum moisture at the time of application of the cement. Do not apply cement on excessively windy days and apply only to such an area that all operations shall be completed on the same day during daylight hours.

The Engineer will establish the actual cement content during construction.

Immediately after the aggregate and cement have been thoroughly blended, apply water as needed and incorporate into the mixture. Control the application of the water so that there is no excessive concentration on or near the surface of the mixture. After the necessary water has been applied, continue mixing until a thorough and uniform mixture is obtained.

Maintain the moisture content at the time of final mixing and during compaction within a range of optimum to optimum plus 1.5% as determined. Make sure that the moisture content in the mix does not exceed the quantity that will cause the base course to become unstable during compaction or finishing operations.

540-6 COMPACTION

Begin compaction immediately after the plant mixed base has been placed on the prepared subgrade or immediately after cement and water has been incorporated into the previously placed aggregate. Compact any one layer of base so the thickness is between 4" to 8"

After spreading, maintain the moisture content of the material within a range of optimum to optimum plus 1.5% moisture during compaction.

Accomplish compaction by the use of approved self-propelled rollers, except do not use a sheep-foot roller for more than 2 passes. Compact the base by the use of approved self-propelled rollers to a density equal to at least 97% of the maximum density obtained by compacting a sample of the material in accordance with AASHTO T 180 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. The Engineer may, at his option, utilize nuclear methods as described in the *NCDOT Nuclear Gauge Operators Manual* to determine the density of the base instead of the methods required above. Copies of this manual are available upon request from the Materials and Tests Unit.

Complete final compaction, including that necessary due to correction of high or low areas, within 3 hours after water has been added to the mixture. Do not leave any cement-aggregate mixture undisturbed for more than 30 minutes if it has not been compacted and finished. When rain causes excessive moisture, reconstruct the entire section. When such reconstruction is necessary, perform the work of reconstruction and provide the cement required at no cost to the Department.

540-7 CONSTRUCTION JOINTS

Build the base for large, wide areas in a series of parallel lines of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a vertical face free of loose or shattered materials. Where traffic considerations require that a longitudinal joint be exposed for an excessive length of time, the Engineer may require that it be covered with a curing seal in accordance with Section 543.

1 540-8 TOLERANCES

2 After final shaping and compacting of the base, the Engineer will check the surface of the
3 base for conformance to the grade and typical section and determine the base thickness.

4 Construct the thickness of the base so that it is within a tolerance of $\pm 1/2$ " of the base
5 thickness required by the plans. When the base course will be used under concrete pavement
6 the tolerance will be $\pm 1/4$ ".

7 Construct the base so that the maximum differential between the established grade and the
8 base within any 100 ft section is $1/2$ " or $1/4$ " when used as a base course under concrete
9 pavement.

10 540-9 CURING

11 After the cement-treated base has been finished as specified herein, cure it in accordance with
12 Section 543.

13 540-10 AGGREGATE FOR CEMENT-TREATED BASE

14 Use aggregate for cement-treated base course from an approved source participating in the
15 Department's Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA
16 Program) which has been sampled, tested and approved in accordance with Section 1010.

17 540-11 TRAFFIC

18 Completed sections of the base may be opened when necessary to lightweight local traffic,
19 provided the base has hardened sufficiently to prevent marring or distorting of the surface and
20 provided the curing is not impaired. Do not operate construction equipment on the base,
21 except as necessary to discharge into the spreader during paving operations.

22 540-12 MAINTENANCE

23 Maintain the base in an acceptable condition until final acceptance of the project. Include
24 immediate repair of any defects or damage that may occur in any maintenance operation.
25 Perform this maintenance at no cost to the Department and repeat as often as may be
26 necessary to keep the base in an acceptable condition. Perform repairs to the base by
27 replacing the base for its full depth rather than by adding a thin layer of cement-stabilized
28 material to the existing layer of base.

29 540-13 MEASUREMENT AND PAYMENT

30 *Aggregate for Cement-Treated Base Course* will be measured and paid at the contract unit
31 price per ton that has been incorporated into the completed and accepted work. The quantity
32 will be measured by weighing in trucks on certified platform scales or other certified
33 weighing devices. No deduction will be made for any moisture contained in the aggregate at
34 the time of weighing. Measurement will not be made of any base mixture added or replaced
35 for corrective measures during construction or for repairing damaged areas.

36 *Portland Cement for Cement-Treated Base Course* will be measured and paid at the contract
37 unit price per ton that has been incorporated into the mix. When bulk cement is used, the
38 quantity will be measured by weighing in trucks on certified platform scales or other certified
39 weighing devices. When cement-treated base is produced at a commercial source for more
40 than one project, the Engineer may elect to measure the cement based upon the cement
41 content shown in the approved job mix formula. Measurement will not be made of any
42 cement added or replaced for corrective measures during construction or for repairing
43 damaged areas.

44 *Asphalt Curing Seal* will be paid in accordance with Article 543-5.

45 *Blotting Sand* will be paid in accordance with Article 818-4.

Section 542

1 The above prices and payments will be full compensation for all work covered by this section
2 including, but not limited to, the furnishing of water and aggregate; the mixing, proportioning,
3 hauling and spreading of the materials; furnishing Portland cement at the point where it is
4 incorporated into the mix; manipulating, compacting and finishing the base; maintaining the
5 base; making repairs or corrections to the base; and applying sand seal in accordance with
6 Article 542-3.

7 If the Contractor fails to provide sand seal as required and the Engineer has the work
8 performed by other forces, the cost of such work will be deducted from monies due or to
9 become due to the Contractor.

10 Payment will be made under

Pay Item	Pay Unit
Aggregate for Cement-Treated Base Course	Ton
Portland Cement for Cement-Treated Base Course	Ton

11 **SECTION 542**
12 **SOIL-CEMENT BASE**

13 **542-1 DESCRIPTION**

14 The work covered by this section consists of constructing and curing a soil-cement base by
15 treating the subgrade, existing subbase or existing base, or any combination of these
16 materials, by pulverizing, adding portland cement, adding aggregate when required, mixing,
17 wetting and compacting the mixture to the required density. Proportion, spread and mix the
18 materials on the roadway; manipulate, compact and finish in accordance with the *Standard*
19 *Specifications* and the lines, grades, depths and typical sections shown on the plans or
20 established by the Engineer.

21 **542-2 MATERIALS**

22 Refer to Division 10.

Item	Section
Aggregate, Std. Size ABC	1005
Portland Cement, Type I	1024-1
Water	1024-4

23 Use soil material that consists of material existing in the area to be paved, approved borrow
24 material or a combination of these materials proportioned as directed by the Engineer that is
25 free from vegetation, roots or other objectionable matter; and does not contain aggregate or
26 stone larger than 2".

27 **542-3 LIMITATIONS**

28 Do not construct the soil-cement base when the air temperature is below 40°F nor when
29 conditions indicate that the temperature may fall below 40°F within 24 hours. Do not place or
30 mix materials with frozen subgrade. Protect the base from freezing for 7 days after
31 completion. Perform the work only during daylight hours except as otherwise provided in the
32 contract.

33 Do not construct soil-cement base that will not be covered with a layer of base or pavement
34 by December 1st of the same year. Failure of the Contractor to cover the soil-cement base as
35 required above will result in the Engineer notifying the Contractor in writing to cover the
36 soil-cement base with a sand seal. Apply the sand seal in accordance with Section 660 except
37 Articles 660-3 and 660-11 will not apply. If the Contractor fails to apply the sand seal within
38 72 hours after a receipt of such notice, the Engineer may proceed to have the work performed
39 with other forces and equipment. The application of the sand seal by the Contractor or other
40 forces will in no way relieve the Contractor of the responsibility to maintain or repair the
41 damaged base, no matter what the cause of damage.

1 542-4 EQUIPMENT**2 (A) General**

3 Use any combination of machines or equipment that will produce the required results meeting
4 the approval of the Engineer. Correct any leakage of fluids and/or materials promptly or the
5 Engineer may order such equipment removed and replaced with satisfactory equipment. Use
6 equipment and methods for applying cement, water, curing seal and blotting sand that will not
7 damage the base and in accordance with Article 107-21.

8 (B) Cement Spreaders

9 Use mechanical spreaders that have an adjustable rate of flow and the capability of
10 spreading the required amount of cement in one pass.

11 (C) Water Distribution Equipment

12 Add water to the soil with a pressure distributor or other suitable equipment capable of
13 uniformly distributing the required amount.

14 (D) Mixers

15 Perform all mixing with a self-propelled rotary mixer. Disc harrows, motor graders and
16 other equipment may be used only to supplement the mixing done by the rotary mixer.

17 Use mixing equipment that is capable of mixing to a compacted depth of at least 10".

18 (E) Compaction Equipment

19 Use self-propelled compaction equipment. Accomplish finish rolling with a pneumatic-
20 tire roller or if permitted by the Engineer, a smooth steel-wheel roller.

21 (F) Scarifying Equipment

22 Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of
23 scarifying the soil to the full depth of the stabilized treatment. When required by the
24 Engineer, use a weeder, spiketooth harrow or nail drag, followed by a broom drag when
25 scarifying during finishing operations.

26 542-5 PREPARATION OF ROADBED

27 Before the addition of any cement to the soil, grade and shape the area to be stabilized in
28 accordance with the typical sections, lines and grades shown on the plans. Perform drying or
29 addition of moisture where necessary before the application of cement. Create the subgrade
30 so it is firm and able to support the construction equipment and compaction operations
31 specified. Correct and make stable, soft or yielding subgrade before construction proceeds.

32 542-6 SCARIFYING

33 Scarify the soil in the area to be stabilized to the required depth and width before application
34 of cement. Pulverizing with a rotary mixer will follow scarifying, except it may be deleted in
35 areas where, if determined, the soil types or conditions make pulverizing with a rotary mixer
36 impractical.

37 542-7 APPLICATION OF CEMENT

38 When the Contractor has brought the subgrade to the elevation required by the plans, the
39 Engineer will sample the soil to be stabilized in order to determine the quantity of cement to
40 be incorporated. Incorporate 24 calendar days into the schedule to allow the Engineer
41 sufficient time to perform the required sampling, testing and final design of the cement
42 stabilization.

43 Before spreading cement, aggregate shall be spread at the rate shown in the plans.

Section 542

1 Incorporate cement into the mix at the rate directed by the Engineer. Uniformly spread the
2 quantity of cement required for the full depth of treatment over the surface in one pass. Do
3 not apply cement on excessively wet grade or on windy days.

4 Apply cement to the soil when the percentage of moisture in the soil material is the correct
5 amount that assures a uniform mixture of soil material and cement during the mixing
6 operation. Do not exceed the optimum moisture content established by the Engineer for the
7 soil-cement mixture except by permission.

8 The optimum moisture content and density will be determined in the field by a moisture-
9 density test on representative samples of soil-cement mixture; however, preliminary moisture-
10 density values may be determined by laboratory tests using soils from the project. Moisture
11 content will be determined by the Engineer in accordance with standard test procedures used
12 by the Department.

13 Apply cement only to such an area that all operations shall be completed in the same day
14 during daylight hours. Complete finishing the soil-cement mix within 4 hours of adding water
15 to the soil-cement mixture. No equipment, except that used in spreading and mixing, will be
16 allowed to pass over the freshly spread cement until it is mixed with the soil. Replace all
17 spread cement that has been displaced before mixing is started.

18 **542-8 MIXING**

19 Immediately after the cement has been spread, mix it with the loosened soil material for the
20 full depth of the treatment until a homogenous and uniform mixture is produced. Mixing will
21 be sufficient when 100% of the mixture passes a 1/2" sieve and at least 80% passes
22 a No. 4 sieve, exclusive of any aggregate.

23 Immediately after mixing the soil and cement, add any additional water that is necessary to
24 bring the moisture content between optimum and optimum plus 2% as determined by the
25 Engineer. If moisture content exceeds the specified range, the soil-cement mixture may, if
26 approved by the Engineer, be manipulated by remixing or blading to reduce the moisture
27 content to within the specified range. Avoid excessive concentrations of water as well as wet
28 spots or streaks on or near the surface. After all mixing water has been applied, continue
29 mixing until a uniform mixture is obtained at the required moisture content. Perform the
30 operations of cement spreading, water application and mixing so that they result in a uniform
31 soil, cement and water mixture for the full depth and width of the area being treated. Remix
32 any soil and cement mixture that has not been compacted and finished within 30 minutes.

33 **542-9 COMPACTION**

34 Begin compaction of the mixture immediately after the mixing operation is completed. At the
35 start of compaction, make sure that the moisture in the mixture is no more than 2% above or
36 below the optimum moisture content and is less than the quantity which will cause the soil-
37 cement mixture to become unstable during compaction and finishing. Compact the mixture to
38 at least 97% of that obtained by a moisture-density test using AASHTO T 134 as modified by
39 the Department. Copies of these modified testing procedures are available upon request from
40 the Materials and Tests Unit.

41 Before compaction, prepare the mixture in a loose condition for its full depth. Compact the
42 loose mixture uniformly to the specified density. During the compaction operations, initial
43 shaping may be required to obtain uniform compaction and required grade and cross section.

44 **542-10 FINISHING**

45 When initial compaction is nearing completion, shape the surface of the soil-cement to the
46 required lines, grades and cross section. Maintain the moisture content of the surface material
47 at optimum or higher during finishing operations.

1 If necessary, lightly scarify the surface to remove any tire imprints or smooth surfaces left by
2 equipment. Continue compaction until a uniform and adequate density is obtained.

3 Perform the compaction and finishing to produce a dense surface free of compaction planes,
4 cracks, ridges or loose material.

5 When rain causes excessive moisture, reconstruct the entire section. Where such
6 reconstruction is necessary, furnish all work and cement required.

7 **542-11 THICKNESS**

8 The compacted thickness of the completed soil-cement base will be determined by
9 measurements made in test holes located at random intervals not to exceed 500 ft. Construct
10 the soil-cement base so that the measured thickness does not deviate from that shown on the
11 plans by more than + 1" or - 1/2".

12 Where the base is deficient in thickness by more than 1/2", remove and replace the area of
13 deficient base with base of the required thickness.

14 As an exception to the above, if the deficiency is not considered sufficient to seriously impair
15 the required strength of the soil-cement base, the deficient area may, at the discretion of the
16 Engineer, be left in place.

17 **542-12 CURING**

18 After the cement-treated base has been finished as specified herein, cure it in accordance with
19 Section 543.

20 **542-13 CONSTRUCTION JOINTS**

21 Build soil-cement for large wide areas in a series of parallel lanes of convenient length and
22 width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of
23 each day's construction by cutting back into completed work to form a true vertical face free
24 of loose or shattered material.

25 Construct joints to provide a vertical joint having adequately mixed properly compacted
26 material immediately adjacent to the joint. A longitudinal joint adjacent to partially hardened
27 soil-cement built the preceding day may be formed by cutting back into the previously
28 constructed area during mixing operations. Set guide stakes for cement spreading and mixing
29 if deemed necessary.

30 **542-14 TRAFFIC**

31 Completed sections of the base may be opened when necessary to light-weight local traffic,
32 provided the base has hardened sufficiently to prevent marring or distorting of the surface and
33 provided the curing is not impaired. Do not use construction equipment on the base for
34 hauling except as necessary to discharge into the spreader during paving operations.

35 **542-15 MAINTENANCE**

36 Maintain the soil-cement base in an acceptable condition until final acceptance of the project.
37 Include, in maintenance operations, immediate repair of any defects or damage that may
38 occur. Repeat as often as may be necessary to keep the base in an acceptable condition.
39 Perform repairs to the base by replacing the base for its full depth rather than by adding a thin
40 layer of soil-cement mixture to the existing layer of base.

Section 543

1 **542-16 MEASUREMENT AND PAYMENT**

2 *Soil Cement Base* will be measured and paid at the contract unit price per square yard that has
3 been completed and accepted. In measuring this quantity, the width of the base will be
4 measured across the top surface of the base. The length will be the actual length constructed,
5 measured along the centerline of the surface of the base. Measurement will not be made
6 of any base added or replaced for corrective measures during construction or for repairing
7 damaged areas.

8 *Aggregate for Soil Cement Base* will be measured and paid in tons at the contract unit price
9 per ton. The aggregate will be measured by weighing in trucks or certified platform scales or
10 other certified weighing devices. No deductions will be made for any moisture contained in
11 the aggregate at the time of weighing.

12 *Portland Cement for Soil Cement Base* will be paid at the contract unit price per ton that has
13 been incorporated into the mix. When bulk cement is used, the quantity will be measured by
14 weighing in trucks on certified platform scales or other certified weighing devices.
15 Measurement will not be made of any cement added or replaced for corrective measures
16 during construction or for repairing damaged areas.

17 Asphalt curing seal will be paid as provided in Article 543-5.

18 *Blotting Sand* will be paid as provided in Article 818-4.

19 If a layer of soil-cement base is deficient in thickness but has been permitted to be left in
20 place in accordance with Article 542-11, payment for that soil-cement base will be made at
21 50% of the contract unit prices for *Soil Cement Base*.

22 Sand seal applied due to the failure of the Contractor to cover the soil-cement base as required
23 will be incidental to the work of this section. If the Contractor fails to provide sand seal as
24 required and the Engineer has the work performed by other forces, the cost of such work will
25 be deducted from monies due or to become due to the Contractor.

26 Payment will be made under:

Pay Item	Pay Unit
Soil Cement Base	Square Yard
Portland Cement for Soil Cement Base	Ton
Aggregate for Soil Cement Base	Ton

27 **SECTION 543**
28 **ASPHALT CURING SEAL**

29 **543-1 DESCRIPTION**

30 Perform the work covered by this section including, but not limited to, keeping the stabilized
31 layer moist; furnishing and applying the asphalt curing seal; correcting, maintaining and
32 repairing the asphalt curing seal; and blotting sand where directed, to either a chemically
33 stabilized soil layer or to a cement-stabilized base course.

34 **543-2 MATERIALS**

35 Refer to Division 10.

Item	Section
Asphalt, Grade CRS-1	1020-6
Asphalt, Grade CRS-1H	1020-6
Asphalt, Grade CRS-2	1020-6
Asphalt, Grade RS-1	1020-5
Asphalt, Grade RS-1H	1020-5

1 **543-3 EQUIPMENT**

2 Use equipment to apply the asphalt material in accordance with Article 600-5.

3 Use equipment to apply water, curing seal and blotting sand that is of such type and weight
4 that it will not damage the completed stabilized layer.

5 **543-4 CONSTRUCTION METHODS**

6 Continuously moisten the finished stabilized layer or base course until the asphalt curing seal
7 is placed. Place the curing seal as soon as possible, but no later than 24 hours after
8 completing finishing operations except where delayed by wet weather. If wet weather delays
9 application of the curing seal, apply the curing seal as soon as the surface becomes
10 sufficiently dry.

11 At the time the asphalt curing seal is applied, prepare the surface of the stabilized layer or
12 base so that it is free of all loose or extraneous material and contains sufficient moisture to
13 prevent excessive penetration of the asphalt material. If deemed necessary, sweep the base
14 surface clean of loose material before applying the curing seal. Apply the curing seal in
15 accordance with Section 600.

16 Apply the asphalt material to the surface of the completed stabilized layer or base at the rate
17 of 0.10 to 0.20 gal/sy with approved equipment. Apply the asphalt material at the exact rate
18 and temperature of application as established by the Engineer.

19 Cure the asphalt material for 7 days. Curing time will be counted in at least 1/2 day units and
20 only when the air temperature in the shade is at least 50°F. Complete the curing before
21 placement of subsequent layers of pavement.

22 Maintain the curing material during the curing period so that all of the stabilized layer or base
23 will be covered effectively during the period. Provide sufficient protection from freezing to
24 the stabilized layer or base during the entire curing period and until it has hardened. Replace
25 excessive loss of curing seal caused by heavy rains within 8 hours of placement.

26 If the Engineer determines that it is necessary to allow local traffic to use parts of the
27 stabilized layer or base before the asphalt material has cured sufficiently, protect those areas
28 by applying blotting sand in accordance with Section 818.

29 **543-5 MEASUREMENT AND PAYMENT**

30 *Asphalt Curing Seal* will be measured and paid at the contract unit price per gallon that has
31 been placed on the stabilized layer or base. Seal material placed on the stabilized layer or
32 base in excess of the authorized rate plus 0.02 gal/sy will not be measured for payment.
33 Measurement will not be made of any curing seal used to replace curing seal lost by heavy
34 rains which occur after placing the curing seal.

35 *Blotting Sand* will be paid as provided for in Article 818-4.

36 Payment will be made under:

Pay Item	Pay Unit
Asphalt Curing Seal	Gallon

Section 545

**SECTION 545
INCIDENTAL STONE BASE**

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545-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing, hauling, placing and shaping a graded stone material for use in driveways, temporary maintenance of traffic, adjacent to mailboxes, beneath traffic island, median covers and at any other locations, other than use as a part of any base course on which pavement is to be placed; shaping; tamping when required; maintaining the base; and disposing of any surplus stockpiled material.

545-2 MATERIALS

Use stone, gravel or recycled concrete for the graded stone material which is well graded from the 1 1/2" through the No. 200 sieve sizes in accordance with Article 1006. The LL of the recycled concrete is raised 5 points to no more than 35.

545-3 GRADATION SAMPLING, TESTING AND ACCEPTANCE

Acceptance of the graded stone material will be made by visual inspection and approval by the Engineer as being satisfactory for the purpose intended before its use. No sampling or testing of the graded stone material will be performed.

545-4 PLACING AND SHAPING STONE

Spread the stone material uniformly over the area required and then shape and dress to the satisfaction of the Engineer.

Uniformly spread, grade to the required depth and firmly tamp the stone material beneath traffic island and median covers. If the Contractor desires, the surface of the stone material may be covered with a sufficient amount of fine material to facilitate grading and shaping.

545-5 MAINTENANCE

Maintain the stone material until final acceptance of the project by reshaping and by the addition of incidental stone base material when directed by the Engineer.

Maintain all stone material beneath traffic islands and median covers in satisfactory condition until the covers are placed.

545-6 MEASUREMENT AND PAYMENT

Incidental Stone Base will be measured and paid at the contract unit price per ton that has been stockpiled or incorporated into the completed and accepted work. This quantity will be measured as provided for in Article 520-11. Incidental stone base which has been stockpiled will not be measured more than one time.

Payment will be made under:

Pay Item	Pay Unit
Incidental Stone Base	Ton

SECTION 560
SHOULDER CONSTRUCTION

560-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing the source of the borrow; building; maintaining and obliterating haul roads; clearing and grubbing the borrow source; removal, hauling and disposition of overburden and other unsuitable material; excavation; hauling; formation of roadway shoulders include the reshaping and finishing of slopes adjacent to the shoulders and roadway ditches; restoration of the source and haul roads to an acceptable condition; disposal of surplus stockpiled material; and seeding and mulching.

560-2 MATERIALS

Refer to Division 10.

Item	Section
Shoulder Borrow	1019-2

560-3 CONSTRUCTION METHODS

Construct the top 6" of shoulders with soils capable of supporting vegetation.

Construct the shoulders in proper sequence with the type of base and pavement being constructed. Perform the work so as to provide proper drainage at all times. Shape and roll the shoulder material during placement to provide for bonding of layers and compaction to a degree satisfactory to the Engineer.

Before placing any earth material on existing graded shoulders, remove all existing vegetation and scarify the existing shoulders to ensure a proper bond.

Perform the final shaping of the shoulders, adjacent slopes and ditches in accordance with the typical section shown on the plans.

Provide adequate equipment to perform the work. Exercise care not to damage base, surface, pavement or drainage features during the construction of the shoulders. Should damage occur because of the Contractor's operations, repair the damaged portions or remove and replace them as directed at no cost to the Department.

560-4 MEASUREMENT AND PAYMENT**(A) General**

Shoulder borrow will be measured in its original position or in the haul truck, as directed by the Engineer.

No measurement will be made of material transported directly from unclassified excavation or fine grading and deposited directly in the place on the shoulder.

The quantity of shoulder borrow will be paid at the contract unit price per cubic yard for *Shoulder Borrow*, except as otherwise provided below.

(B) Measured in Original Position

The quantity of shoulder borrow to be paid will be the actual number of cubic yards of approved material, measured in its original position in the borrow source or stockpile by cross sectioning and computed by the average end area method, which has been incorporated into the completed and accepted work. No measurement will be made of any overburden or unsuitable material removed from the borrow source, nor of any material excavated before cross sections being taken.

Section 560

1 **(C) Truck Measurement**

2 The quantity of shoulder borrow to be paid will be the actual number of cubic yards of
3 approved material, measured in trucks, which has been incorporated into the completed
4 and accepted work. Each truck will be measured by the Engineer and shall bear a legible
5 identification mark indicating its capacity. Load each truck to its measured capacity at
6 the time it arrives at the point of delivery. The recorded capacity will be adjusted by
7 making a 25% deduction to allow for shrinkage, and the adjusted capacity will be the
8 quantity to be paid.

9 When shoulder material is obtained as a result of fine grading operations, trenching out
10 existing subgrade or shaping slopes and ditches, no direct payment will be made for the
11 work of shoulder construction as such work will be incidental to the work of constructing
12 the base or pavement.

13 No payment will be made for the removal and disposal of any surplus material remaining
14 in the stockpile after the shoulders have been completed.

15 Where the borrow source has been furnished by the Department, payment for clearing
16 and grubbing the source will be made as provided in Article 200-8 and payment for
17 draining the source will be made as provided in Article 240-4. Where the source has
18 been furnished by the Contractor, no separate payment will be made for clearing and
19 grubbing or draining the source as such work will be incidental to the work covered by
20 this section.

21 If aggregate shoulder borrow (ASB) is used for borrow, a unit weight of 140 lb/cf will be
22 used to convert the weight of ASB to cubic yards.

23 Payment for seeding and mulching all borrow sources will be made at the contract unit prices
24 for the items established in the contract as payment for the work of seeding and mulching.

25 Payment will be made under:

Pay Item

Shoulder Borrow

Pay Unit

Cubic Yard

DIVISION 6 ASPHALT PAVEMENTS

SECTION 600 PRIME COAT

1

2

3 **600-1 DESCRIPTION**

4 Perform the work covered by this section including, but not limited to, treating an existing
5 non-asphalt base course with asphalt material by furnishing and applying the prime,
6 furnishing and placing granular material to protect the prime and maintaining the prime coat
7 in accordance with these Specifications.

8 Treat all non-asphalt bases beneath an asphalt surface treatment with a prime coat.

9 **600-2 MATERIALS**

10 Refer to Division 10.

Item

Prime Coat Materials

Section

1020-5

11 Use materials for prime coat application that are on the Materials and Tests Unit's Approved
12 Product List for prime coats available on the Department's website. Materials shall meet the
13 manufacturer's specifications as submitted to and approved by the Department.

14 Where the grade of prime coat material is not established by the contract, the Contractor may
15 select the grade to be used from the Approved Product List. All prime coat materials shall be
16 delivered to the project ready for use.

17 **600-3 WEATHER LIMITATIONS**

18 Apply prime coat only when the surface to be treated is free of standing water, at proper
19 moisture content and the atmospheric temperature in the shade away from artificial heat is
20 40°F or above for plant mix and 50°F or above for asphalt surface treatment.

21 Do not apply prime coat on a frozen surface or when the weather is foggy or rainy.

22 **600-4 BASE PREPARATION**

23 Clean the base of objectionable debris, excessive dust and any other deleterious matter before
24 placing the prime coat.

25 When directed, dampen the surface of the base before application of the prime coat.

26 **600-5 APPLICATION EQUIPMENT**

27 Provide, maintain and operate a pressure distributor that is designed and equipped such that
28 the asphalt material remains at a constant temperature and may be applied uniformly on
29 variable widths of surface at predetermined and controlled rates. Use a distributor equipped
30 with a tachometer or synchronizer, pressure gauges, accurate volume measuring devices or
31 a calibrated tank and a mounted thermometer for measuring temperature.

32 Use a distributor equipped with a power driven pump of sufficient capacity to distribute the
33 required quantity of asphalt material at constant flow and uniform pressure. Provide a full
34 circulation spray bar adjustable laterally and vertically and adjustable in length to conform to
35 the required width of application without overlapping. Provide and maintain nozzles designed
36 to provide equal and uniform application at all times. Provide a hand spray hose and nozzle
37 to cover areas inaccessible to the spray bars. Equip the distributor with a positive shut-off
38 control for the spray bar and hand hose.

Section 605

1 **600-6 APPLICATION RATES AND TEMPERATURES**

2 Apply the prime coat at a rate from 0.20 to 0.50 gal/sy. The exact rate for each application
3 will be established by the Engineer before application, in accordance with the limits shown in
4 the Approved Product List referenced in Article 600-2.

5 The required rate of application of asphalt materials will be based on the volume of material
6 measured at the application temperature. Apply the prime coat material at a temperature that
7 is in accordance with the manufacturer's recommendations or as approved.

8 **600-7 APPLICATION OF PRIME COAT**

9 When the plans require the base course to be constructed with side slopes flatter than 1:1,
10 apply prime to the full width of the base including the side slopes.

11 Apply the prime coat only when the base to be treated has been approved.

12 Place a string line to provide alignment control for the distributor during prime coat
13 application unless waived by the Engineer.

14 Cover bridge floors, curbs and handrails of structures and all other appurtenances to protect
15 them from tracking or splattering of prime coat.

16 After the prime coat has penetrated sufficiently and when directed, roll the primed surface
17 until all loose base material is thoroughly bonded.

18 **600-8 MAINTENANCE AND PROTECTION**

19 Allow the prime coat to thoroughly penetrate the base. When directed, apply blotting sand in
20 accordance with Section 818.

21 Maintain the prime coat in an acceptable condition until such time as the pavement is placed.
22 Replace any damaged prime coat.

23 **600-9 MEASUREMENT AND PAYMENT**

24 Ensure the volume of the distributor tank is calibrated by a commercial laboratory or the
25 manufacturer before use. Provide a calibration chart with an accurately calibrated measuring
26 stick graduated in increments of not more than 25 gallons on the distributor at all times for use
27 by the Engineer.

28 *Prime Coat* will be paid at the contract unit price per gallons of prime coat material
29 satisfactorily placed on the roadway. Each distributor load of prime coat material delivered
30 and used on the project will be measured. Replaced damaged prime coat at no cost to the
31 Department.

32 *Blotting Sand* will be paid in accordance with Article 818-4.

33 Payment will be made under:

Pay Item	Pay Unit
Prime Coat	Gallon

34 **SECTION 605**
35 **ASPHALT TACK COAT**

36 **605-1 DESCRIPTION**

37 Apply tack coat material to existing asphalt or concrete surfaces in accordance with these
38 Specifications.

39 Apply tack coat beneath each layer of asphalt plant mix to be placed, unless otherwise
40 approved. Where a prime coat or a newly placed asphalt surface treatment mat coat has been
41 applied, apply tack coat as directed.

1 **605-2 MATERIALS**

2 Refer to Division 10.

Item	Section
Asphalt Binder, Grade PG 64-22	1020-2
Emulsified Asphalt, Grade CRS-1	1020-3
Emulsified Asphalt, Grade CRS-1H	1020-3
Emulsified Asphalt, Grade CRS-2	1020-3
Emulsified Asphalt, Grade HFMS-1	1020-3
Emulsified Asphalt, Grade RS-1H	1020-3

3 Do not dilute or mix the tack coat material with water, solvents or other materials before
4 application.

5 Unless otherwise specified in the contract, use any of the grades of tack coat material
6 specified in this article.

7 For tack coat beneath an open-graded asphalt friction course, the asphalt grade and rate of
8 application to be used on the project will be specified in accordance with Section 650-5.

9 **605-3 WEATHER LIMITATIONS**

10 Apply tack coat only when the surface to be treated is dry and when the atmospheric
11 temperature in the shade away from artificial heat is 35°F or above.

12 Do not apply tack coat when the weather is foggy or rainy.

13 **605-4 SURFACE PREPARATION**

14 Ensure that the existing asphalt or concrete surface is free of all dust and foreign material
15 before applying the tack coat.

16 Remove grass, dirt and other materials from the edge of the existing pavement before the
17 placement of tack coat.

18 **605-5 ACCEPTANCE OF ASPHALT MATERIALS**

19 The acceptance of asphalt materials will be in accordance with Article 1020-1.

20 **605-6 APPLICATION EQUIPMENT**

21 Provide equipment for heating and uniformly applying the asphalt material in accordance with
22 Article 600-5.

23 **605-7 APPLICATION RATES AND TEMPERATURES**

24 Apply tack coat uniformly at a rate from 0.04 to 0.08 gal/sy. The exact rate for each
25 application will be established by the Engineer. A different rate of application for different
26 layers or surfaces may be established.

27 The established rates of application will be based on the volume of material at the actual
28 application temperature. Apply tack coat at a temperature within the ranges shown in
29 Table 605-1.

Section 607

TABLE 605-1 APPLICATION TEMPERATURE FOR TACK COAT	
Asphalt Material	Temperature Range
Asphalt Binder, Grade PG 64-22	350 - 400°F
Emulsified Asphalt, Grade RS-1H	90 - 150°F
Emulsified Asphalt, Grade CRS-1	90 - 150°F
Emulsified Asphalt, Grade CRS-1H	90 - 150°F
Emulsified Asphalt, Grade HFMS-1	90 - 160°F
Emulsified Asphalt, Grade CRS-2	125 - 185°F

1 **605-8 APPLICATION OF TACK COAT**

2 Apply only as much tack coat material as can be covered with base, intermediate or surface
3 course material during the next day's operation except where public traffic is being
4 maintained.

5 If public traffic is being maintained, cover the tack coat in the same day's operation. Provide
6 safe traffic conditions. If needed, apply suitable granular material so it bonds to the tack coat.
7 In addition, the Engineer may limit the application of tack coat in advance of the paving
8 operation depending on traffic conditions, project location, proximity to business or
9 residential areas or other reasons.

10 Take necessary precautions to limit the tracking or accumulation of tack coat on either
11 existing or newly constructed pavements. Excessive accumulation of tack coat requires
12 corrective measures.

13 Apply tack coat with a distributor spray bar that can be adjusted to uniformly coat the entire
14 surface at the directed rate. Use a hand hose attachment only on irregular areas and areas
15 inaccessible to the spray bar. Cover these areas uniformly and completely.

16 Apply tack coat as directed by and in the presence of the Engineer. Do not place any asphalt
17 mixture until the tack coat has sufficiently cured.

18 Apply tack coat to all exposed transverse and longitudinal edges of each course before
19 mixture is placed adjacent to such surfaces. Apply tack coat to contact surfaces of headers,
20 curbs, gutters, manholes and vertical faces of old pavements.

21 Cover bridge floors, curbs and handrails of structures and all other appurtenances to protect
22 them from tracking or splattering tack coat material.

23 **605-9 PROTECTION OF TACK COAT**

24 After the tack coat has been applied, protect it until it has cured for a sufficient length of time
25 to prevent it from being picked up by traffic.

26 **605-10 MEASUREMENT AND PAYMENT**

27 There will be no direct payment for the work covered by this section.

28 Payment at the contract unit prices for the various mix items covered by Sections 610, 650
29 and 654 will be full compensation for all work covered by this section.

30 **SECTION 607** 31 **MILLING ASPHALT PAVEMENT**

32 **607-1 DESCRIPTION**

33 Perform the work covered by this section including, but not limited to, milling and re-milling
34 the pavement at locations, depths, widths and typical sections indicated in the contract;
35 cleaning the milled surface; loading, hauling and stockpiling the milled material for use in
36 recycled asphalt mixtures; and disposal of any excess milled material.

1 Except where the milled material is used in the work or where otherwise directed, provide
2 areas outside the right of way to dispose of milled material, which shall be property of the
3 Contractor.

4 **607-2 EQUIPMENT**

5 Use a self-propelled unit capable of removing the existing asphalt pavement to the depths,
6 widths and typical sections shown in the contract. Use milling machines designed and built
7 exclusively for pavement milling operations and with sufficient power, traction and stability
8 to accurately maintain depth of cut and slope. Use milling machines equipped with
9 an electronic control system that will automatically control the longitudinal profile and cross
10 slope of the milled pavement surface. Accomplish this through the use of a mobile grade
11 reference, an erected string line, joint matching shoe, slope control systems or a combination
12 of approved methods. Use an erected fixed stringline when required by the contract.
13 Otherwise, use a mobile grade reference system capable of averaging the existing grade or
14 pavement profile over at least 30 ft. Use either a non-contacting laser or sonar type ski
15 systems with at least 4 referencing stations mounted on the milling machine at a length of at
16 least 24 ft. Coordinate the position of the grade control system such that the grade sensor is at
17 the approximate midpoint of the mobile reference system. Use a machine capable of leaving
18 a uniform surface suitable for handling traffic without damage to the underlying pavement
19 structure. Use a milling machine and other loading equipment capable of loading milled
20 material to be used in other parts of the work without segregation.

21 Provide additional equipment necessary to satisfactorily remove the pavement in the area of
22 manholes, water valves, curb, gutter and other obstructions.

23 Equip the milling equipment with a means of effectively limiting the amount of dust escaping
24 from the removal operation in accordance with Federal, State and local air pollution control
25 laws and regulations.

26 **607-3 CONSTRUCTION METHODS**

27 Mill the existing pavement to restore the pavement surface to a uniform longitudinal profile
28 and cross section in accordance with typical sections shown in the plans. Where indicated in
29 the contract, remove pavement to a specified depth and produce a specified cross slope. Mill
30 intersections and other irregular areas unless otherwise directed by the Engineer.

31 The Contractor may elect to make multiple cuts to achieve the required depth of cut or cross
32 slope required by the plans.

33 Establish the longitudinal profile of the milled surface by a mobile string line on the side of
34 the cut nearest the centerline of the road. Establish the cross slope of the milled surface by
35 an automatic cross slope control mechanism or by a second skid sensing device located on the
36 opposite edge of the cut. The Engineer may waive the requirement for automatic grade and
37 cross slope controls where conditions warrant.

38 Operate the milling equipment so as to prevent damage to the underlying pavement structure,
39 utilities, drainage facilities, curb and gutter, paved surfaces outside the milled area and any
40 other appurtenances. Produce milled pavement surfaces that are reasonably smooth and free
41 of excessive scarification marks, gouges, ridges, continuous grooves or other damage. Repair
42 any leveling or patching required as a result of negligence by the Contractor with hot asphalt
43 plant mix in a manner acceptable to the Engineer. Coordinate the adjustment of manholes,
44 meter boxes and valve boxes with the milling operation in accordance with Article 858-3
45 including a temporary asphalt ramp.

Section 607

1 When necessary, the contractor may remove the top section of a utility and use a bridge steel
2 plate placed to cover the entire width of the structure, ensuring no debris is dropped inside the
3 structure. Backfill with compacted material and hot mix asphalt as a temporary riding surface
4 as well as any further necessary requirements of the utility owner. This steel plate must be
5 capable of carrying any traffic load carried by the facility. Where necessary, double-reference
6 the location of each structure that has been removed and maintain a map of their location.
7 Construct a temporary ramp of asphalt plant mix to extend a minimum of 3 ft around raised
8 structures before opening to traffic.

9 The Engineer may require re-milling of any area exhibiting laminations or other defects.
10 Thoroughly clean the milled pavement surface of all loose aggregate particles, dust and other
11 objectionable material. Disposing or wasting of oversize pieces of pavement or loose
12 aggregate material will not be permitted within the right of way.

13 Conduct pavement removal operations so as to effectively minimize the amount of dust being
14 emitted. Plan and conduct the operation so it is safe for persons and property adjacent to the
15 work including the traveling public.

16 **607-4 TOLERANCE**

17 Remove the existing pavement to the depth required by the contract. The Engineer may vary
18 the depth of milling.

19 **607-5 MEASUREMENT AND PAYMENT**

20 **(A) Milled Asphalt Pavement**

21 *Milled Asphalt Pavement, ___" Depth and Milling Asphalt Pavement, ___" to ___"* to be paid
22 will be the actual number of square yards of pavement surface milled in accordance with
23 this Specification. In measuring this quantity, the length will be the actual length milled,
24 measured along the pavement surface. The width will be the width required by the plans
25 or directed, measured along the pavement surface.

26 **(B) Milled Asphalt Pavement Depth Varies from Required Depth**

27 Where the depth of milling varies from the required depth, no adjustment in the contract
28 unit price for *Milling Asphalt Pavement, ___" Depth and Milling Asphalt*
29 *Pavement, ___" to ___"* will be made, except if the Engineer directs the depth of milling per
30 cut to be altered by more than 1". In this case, either the Department or the Contractor
31 may request an adjustment in unit price in accordance with Article 104-3. In
32 administering Article 104-3, the Department will give no consideration to value given to
33 RAP due to the deletion or reduction in quantity of milling. Article 104-3 will not apply
34 to the item of *Incidental Milling*.

35 For each square yard that the Engineer directs to be milled, including, but not limited to,
36 the mainline, turn lanes, bus loading and unloading areas, widening for bus or truck
37 U-turns, shoulders, intersections and crossovers requiring any additional equipment
38 necessary to remove pavement in the area of manholes, water valves, curb, gutter and
39 other obstructions, compensation will be made at the contract unit price per square yard
40 for *Milling Asphalt Pavement, ___" Depth or Milling Asphalt Pavement, ___" to ___"*.

41 **(C) Incidental Milling**

42 Where the Contractor is required to re-mill areas that are not due to the Contractor's
43 negligence and whose length is less than 100 ft or butt joints that are not a portion of the
44 milling areas outlined in Subarticle 607-5(B), measurement will be made as provided in
45 Subarticle 607-5(A) for each cut he is directed to perform. Where the Contractor elects
46 to make multiple cuts to achieve the final depth, no additional measurement will be made.
47 Compensation will be made at the contract unit price per square yard for *Incidental*
48 *Milling*.

(D) Milling of Defects

If defects are determined to be the result of the Contractor's negligence, then measurement for the re-milling or repairs will not be made. If the Engineer directs re-milling of an area that is equal to or greater than 100 ft and is not due to the Contractor's negligence, the re-milled area will be measured as provided in Subarticle 607-5(A) and paid at the contract unit price per square yard for *Milled Asphalt Pavement*, ___" *Depth* or *Milling Asphalt Pavement*, ___" to ___".

Payment will be made under:

Pay Item	Pay Unit
Milling Asphalt Pavement, ___" to ___"	Square Yard
Milling Asphalt Pavement, ___" Depth	Square Yard
Incidental Milling	Square Yard

SECTION 609**QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS****609-1 DESCRIPTION**

Produce and construct asphalt mixtures and pavements in accordance with a quality management system as described herein. Apply these *Standard Specifications* to all materials and work performed in accordance with Division 6. Perform all QC activities in accordance with the Department's *Hot Mix Asphalt Quality Management System (HMA/QMS) Manual* in effect on the date of contract advertisement, unless otherwise approved.

(A) Quality Control (QC)

Define a "quality control (QC) program" as all activities, including mix design, process control, plant and equipment calibration, sampling and testing and necessary adjustments in the process that are related to production of a pavement that meet the *Standard Specifications*. Provide and conduct a QC program in accordance with this section.

(B) Quality Assurance (QA)

Define a "quality assurance (QA) program" as all activities, including inspection, sampling and testing related to determining that the quality of the completed pavement conforms to specification requirements. The Department will conduct a QA program in accordance with Article 609-10.

609-2 MIX DESIGN/JOB MIX FORMULA REQUIREMENTS

Apply all requirements of Article 610-3.

609-3 FIELD VERIFICATION OF MIXTURE AND JOB MIX FORMULA ADJUSTMENTS

Conduct field verification of the mix at each plant within 30 calendar days before initial production of each mix design, when required by the Allowable Mix Adjustment Policy and when directed as deemed necessary.

Field verification testing consists of performing a minimum of one full test series on mix sampled and tested in accordance with Subarticle 609-6(B). When producing warm mix asphalt (WMA), field verification testing will include performing a tensile strength ratio (TSR) testing in accordance with AASHTO T 283 as modified by the Department. Mix obtained from Department or non-Department work may be used for this purpose provided it is sampled, tested and the test data handled in accordance with the *HMA/QMS Manual* and this article.

Section 609

1 Obtain the mix verification sample and split in accordance with procedures in the
2 *HMA/QMS Manual*. Do not begin normal plant production until all field verification test
3 results have been completed and the mix has been satisfactorily verified by the Contractor's
4 Level II technician. Verification is satisfactory for HMA when all volumetric properties
5 except percent maximum specific gravity at initial number of gyrations ($\%G_{mm}@N_{ini}$) are
6 within the applicable mix design criteria, and the gradation, binder content and $\%G_{mm}@N_{ini}$
7 are within the individual limits for the mix type being produced. Verification is satisfactory
8 for WMA when all volumetric properties except $\%G_{mm}@N_{ini}$ are within the applicable mix
9 design criteria, the TSR is equal to or above the minimum design criteria, and the gradation,
10 binder content and $\%G_{mm}@N_{ini}$ are within the individual limits for the mix type being
11 produced.

12 In addition to the required sampling and testing for field verification, perform all preliminary
13 inspections and plant calibrations as outlined in the *HMA/QMS Manual*. Retain records of
14 these calibrations and mix verification tests, including superpave gyratory compactor
15 printouts, at the QC laboratory. Furnish copies, including superpave gyratory compactor
16 printouts, to the Engineer for review and approval within one working day after beginning
17 production of the mix.

18 Conduct the initial mix verification of all new mix designs with the plant set up to produce the
19 aggregate blend and binder content in accordance with the initially approved JMF. If the
20 Contractor or the Engineer determines from results of QC tests conducted during mix
21 verification that adjustments to the JMF are necessary to achieve specified mix properties,
22 adjustments to the JMF may be made within tolerances permitted by the *Standard*
23 *Specifications* for the mix type being produced, subject to approval. No reduction of asphalt
24 binder content will be made when the average production VMA computes below the
25 minimum specification requirement. Obtain written approval by the Engineer for all JMF
26 adjustments.

27 Failure by the Contractor to fully comply with the above mix verification requirements will
28 result in immediate production stoppage by the Engineer. Do not resume normal production
29 until all mix verification sampling, testing, calibrations and plant inspections have been
30 performed and approved.

31 **609-4 CONTRACTOR'S QUALITY CONTROL PERSONNEL REQUIREMENTS**

32 Obtain all certifications in accordance with the Department's QMS Asphalt Technician
33 Certification Program as outlined in the *HMA/QMS Manual*. Perform all sampling, testing,
34 data analysis and data posting by or under the direct supervision of a certified QMS asphalt
35 plant technician.

36 Provide a certified asphalt plant technician Level I to perform QC operations and activities at
37 each plant site at all times during production of material for the project. A plant operator who
38 is a certified asphalt plant technician Level I may be used to meet this requirement when daily
39 production for each mix design is less than 100 tons provided the randomly scheduled
40 increment sample as defined in Subarticle 609-6(B) is not within that tonnage. When
41 performing in this capacity, the plant operator will be responsible for all QC activities that are
42 necessary and required. Absences of the Level I technician, other than those for normal
43 breaks and emergencies shall be pre-approved by the appropriate QA supervisor or his
44 designated representative. Any extended absence of the technician that has not been approved
45 will result in immediate suspension of production by the Engineer. All mix produced during
46 this absence will be accepted in accordance with Article 105-3.

47 Provide and have readily available a certified asphalt plant technician Level II to supervise,
48 coordinate and make any necessary adjustments in the mix QC process in a timely manner.
49 The Level II technician may serve in a dual capacity and fulfill the Level I technician
50 requirements specified above.

1 Provide a certified QMS roadway technician with each paving operation at all times during
 2 placement of asphalt. This person is responsible for monitoring all roadway paving
 3 operations and all QC processes and activities, to include stopping production or
 4 implementing corrective measures when warranted. Provide a certified density gauge
 5 operator when density control is being used.

6 Post in the QC laboratory an organizational chart, including names, telephone numbers and
 7 current certification numbers of all personnel responsible for the QC program while asphalt
 8 paving work is in progress.

9 **609-5 CONTRACTOR'S QUALITY CONTROL FIELD LABORATORY REQUIREMENTS**

10 For a contract with 5,000 or more total tons of asphalt mix, furnish and maintain
 11 a Department certified laboratory at the plant site. A minimum of 320 sf of floor space
 12 exclusive of toilet facilities, equipment and supplies necessary for performing Contractor
 13 QC testing is required. Provide convenient telephone and fax machine access for
 14 QMS personnel at the plant site.

15 For a contract with less than 5,000 total tons of asphalt mix, the QC testing may be conducted
 16 in a Department certified off-site laboratory meeting the requirements herein.

17 Provide testing equipment required in the test methods in Subarticle 609-6(B). Provide
 18 equipment that is properly calibrated and maintained. Allow all measuring and testing
 19 devices to be inspected to confirm both calibration and condition. If at any time the Engineer
 20 determines that the equipment is not operating properly or is not within the limits of
 21 dimensions or calibration described in the applicable test method, the Engineer may stop
 22 production until corrective action is taken. Maintain and have available a record of all
 23 calibration results at the laboratory.

24 **609-6 PLANT MIX QUALITY CONTROL**

25 **(A) General**

26 Include in the QC process the preliminary inspections, plant calibrations and field
 27 verification of the mix and JMF in accordance with Article 609-4. Conduct at
 28 a minimum the sampling, testing and determination of all parameters outlined in these
 29 *Standard Specifications* using test methods and minimum frequencies as specified.
 30 Perform additional sampling and testing when conditions dictate. Obtain all scheduled
 31 samples at randomly selected locations in accordance with the *HMA/QMS Manual*. Log
 32 all samples taken on forms provided by the Department. Split and retain all samples
 33 taken in accordance with the *HMA/QMS Manual*. Provide documentation as required in
 34 Subarticle 609-8. Identify any additional QC samples taken and tested on the appropriate
 35 forms. Process control test results shall not be plotted on control charts nor reported to
 36 the QA Laboratory.

37 Retain the untested split portion of QC aggregate and mix samples and the tested TSR
 38 specimens for 5 calendar days at the plant site, commencing the day the samples are
 39 tested. Retain the QC compacted volumetric test specimens for 5 calendar days,
 40 commencing the day the specimens are prepared. Permission for disposal may be given
 41 by QA personnel before these minimum storage periods. Retain the split portion of the
 42 Contractor's mix verification and referee mix samples until either procured by
 43 QA personnel or permission for disposal is given by QA personnel. Store all retained
 44 samples in a dry and protected location.

45 **(B) Required Sampling and Testing Frequencies**

46 Maintain minimum test frequencies as established in the schedule below. Complete all
 47 tests within 24 hours of the time the sample is taken, unless specified otherwise within
 48 these provisions. If the specified tests will not be completed within the required time
 49 frame, cease production at that point until such time the tests are completed.

Section 609

1 If the Contractor's testing frequency fails to meet the minimum frequency requirements
2 as specified, all mix without the specified test representation will be unsatisfactory. The
3 Engineer will evaluate if the mix may remain in place in accordance with Article 105-3.

4 If desired, innovative equipment or techniques not addressed by these *Standard*
5 *Specifications* to produce or monitor the production of mix may be used, subject to
6 approval.

7 Sample and test the completed mixture from each JMF at the following minimum
8 frequency during mix production:

<u>Accumulative Production Increment</u>	<u>Number of Samples per Increment</u>
750 tons	1

9 If production is discontinued or interrupted before the accumulative production increment
10 tonnage is completed, continue the increment on the next production day(s) until the
11 increment tonnage is completed. Obtain a random sample within the specified increment
12 at the location determined in accordance with the *HMA/QMS Manual*. Conduct
13 QC testing on each random sample in accordance with Section 7.3 of the *HMA/QMS*
14 *Manual*. When daily production of each mix design exceeds 100 tons and a regularly
15 scheduled full test series on a sample from a random sample location for that JMF does
16 not occur during that day's production, perform at least one partial test series in
17 accordance with Section 7.3 of the *HMA/QMS Manual*. These partial test series and
18 associated tests do not substitute for the regularly scheduled random sample for that
19 increment.

20 (C) Control Charts

21 Maintain standardized control charts furnished by the Department at the field laboratory.
22 For mix incorporated into the project, record full test series data from all regularly
23 scheduled random samples or directed samples that replace regularly scheduled random
24 samples, on control charts the same day the test results are obtained.

25 In addition, partial test series results obtained due to reasons outlined in
26 Subarticle 609-6(B) will be reported to QA personnel on the proper forms, but will not be
27 plotted on the control charts.

28 Results of QA tests performed by the Engineer will be posted on the Contractor's control
29 charts as data becomes available.

30 Record QC sample data on the standardized control charts in accordance with Section 7.4
31 of the *HMA/QMS Manual*.

32 Both the full test series individual test values and the moving average of the last 4 data
33 points will be plotted on each chart. The Contractor's test data will be shown in black
34 and the moving average in red. The Engineer's assurance data will be plotted in blue.
35 Denote the moving average control limits with a dash green line and the individual test
36 limits with a dash red line.

37 Maintain a continuous moving average with the following exceptions.

38 Re-establish a new moving average only when:

- 39 (1) A change in the binder percentage, aggregate blend or G_{mm} is made on the JMF, or
40 (2) When the Contractor elects to stop or is required to stop production after one or two
41 moving average values, respectively, fall outside the moving average limits as
42 outlined in Subarticle 609-6(E), or
43 (3) If failure to stop production after 2 consecutive moving averages exceed the moving
44 average limits occurs, but production does stop at a subsequent time, re-establish
45 a new moving average beginning at the actual production stop point.

1 In addition, re-establish the moving averages for all mix properties. Moving averages
 2 will not be re-established when production stoppage occurs due to an individual test
 3 result exceeding the individual test limits or the *Standard Specifications*.

4 All individual test results for regularly scheduled random samples or directed samples
 5 that replace regularly scheduled samples are part of the plant QC record and shall be
 6 included in moving average calculations with the following exception.
 7 When the Contractor's testing data has been proven incorrect, use the correct data as
 8 determined by the Engineer instead of the Contractor's data to determine the appropriate
 9 pay factor in accordance with Subarticle 609-6(E). In this case, replace the data in
 10 question and any related data proven incorrect.

11 (D) Control Limits

12 Establish control limits for mix production in accordance with Table 609-1. Control
 13 limits for the moving average limits are based on a moving average of the last 4 data
 14 points. Apply all control limits to the applicable target source.

Mix Control Criteria	Target Source	Moving Average Limit	Individual Limit
2.36 mm Sieve	JMF	± 4.0%	± 8.0%
0.075 mm Sieve	JMF	± 1.5%	± 2.5%
Binder Content	JMF	± 0.3%	± 0.7%
VTM @ N _{des}	JMF	± 1.0%	± 2.0%
VMA @ N _{des}	Min. Spec. Limit	Min. Spec. Limit	- 1.0%
P _{0.075} / P _{be} Ratio	Max. Spec. Limit	± 0.4 %	± 0.8%
% G _{mm} @ N _{ini}	Max. Spec. Limit	-	+ 2.0%
TSR	Min. Spec. Limit	-	- 15%

15 (E) Corrective Actions

16 All required corrective actions are based upon initial test results and shall be taken
 17 immediately upon obtaining those results. If more than one corrective action or
 18 adjustment applies, give precedence to the more severe of these actions. Stopping
 19 production when required takes precedence over all other corrective actions. Document
 20 all corrective actions.

21 If the process adjustment improves the property in question such that the moving average
 22 after 4 additional tests is on or within the moving average limits, the Contractor may
 23 continue production.

24 When any of the following occur, production of a mix shall cease immediately:

- 25 (1) An individual test result for a mix control criteria (including results for required
 26 partial test series on mix) exceeds both the individual test control limits and the
 27 applicable specification design criteria, or
- 28 (2) Two consecutive field TSR values fail to meet the minimum specification
 29 requirement, or
- 30 (3) Two consecutive binder content test results exceed the individual limits, or
- 31 (4) Two consecutive moving average values for any one of the mix control criteria fall
 32 outside the moving average limits.

Section 609

- 1 Do not resume normal plant production until one of the following has occurred.
- 2 Option 1: Approval has been granted by the appropriate QA supervisor.
- 3 Option 2: The mix in question has been satisfactorily verified in accordance with
4 Article 609-3. Normal production may resume based on the approval of the
5 contractor's Level II technician, provided notification and the verification test
6 results have been furnished to the QA Laboratory.
- 7 Failure to fully comply with any of the above corrective actions will result in immediate
8 production stoppage by the Engineer. Normal production shall not resume until
9 a complete verification process has been performed and approved by the Engineer.
- 10 Failure to stop production when required will make all mix unacceptable from the stop
11 point tonnage to the point when Option 1 or Option 2 occurs or to the tonnage point when
12 production is actually stopped, whichever occurs first.
- 13 In any case, remove and replace this mix with materials that comply with the *Standard*
14 *Specifications*, unless otherwise approved. The Engineer will evaluate acceptance of the
15 mix in question based on Articles 105-3 and 609-11.
- 16 Immediately notify the Engineer when any moving average value exceeds the moving
17 average limit. If 2 consecutive moving average values for any one of the mix control
18 criteria fall outside the moving average limits, immediately notify the Engineer of the
19 stoppage and make adjustments. The Contractor may elect to stop production after only
20 one moving average value falls outside the moving average limits. In either case, do not
21 determine a new moving average until the fourth test after the elective or mandatory stop
22 in production.

23 (F) Allowable Retesting for Mix Deficiencies

24 The Contractor may elect to resample and retest for plant mix deficiencies when
25 individual QC test(s) exceed one or more mix property target(s) by more than the
26 tolerances indicated below. Perform the retesting within 10 days after initial test results
27 are determined. Retesting shall be approved before being performed and in accordance
28 with the *HMA/QMS Manual*. The Contractor, under the supervision of the Department's
29 QA personnel, will perform these retests. Retests for any mix deficiency other than as
30 listed below will not be allowed, unless otherwise permitted. Acceptance of the mix in
31 question will be based on the retest data in accordance with Article 105-3.

32 The Department reserves the right to require the Contractor to resample and retest at any
33 time or location as directed.

Property	Limit
VTM	by more than $\pm 2.5\%$
VMA	by more than $\pm 2.0\%$
% Binder Content	by more than $\pm 1.0\%$
0.075 mm sieve	by more than $\pm 3.0\%$
2.36 mm sieve	exceeds both the Specification mix design limits and one or more of the above tolerances
TSR	by more than - 15% from Specification limit

609-7 FIELD COMPACTION QUALITY CONTROL**(A) General**

Perform QC of the compaction process in accordance with these provisions and applicable requirements of Article 610-10. The Contractor may elect to use either cored sample density procedures or density gauge procedures. Provide to the Department at the pre-construction conference the method of density QC that will be used on the project.

Establish acceptable control strips when required at locations approved by the Engineer. Construct control strips that are 300 ft in length at the paver laydown width being placed. When using core sample control, place control strips anytime placement is proceeding on limited production due to failing densities. When using density gauge control, place control strips at the minimum frequencies specified in the Department's *Density Gauge Operator's Manual*. In addition, place control strips anytime deemed necessary by the Engineer.

Conduct density sampling and testing by either method based on test sections consisting of not more than 2,000 lf or fraction thereof per day on pavement placed at the paver laydown width. Perform density sampling and testing on all pavements as outlined in Section 10.4 of the *HMA/QMS Manual* unless otherwise approved.

Perform the sampling and testing at the minimum test frequencies as specified above. If the density testing frequency fails to meet the minimum frequency as specified above, all mix without the required density test representation will be unsatisfactory. The Engineer will evaluate if the mix may remain in place in accordance with Article 105-3.

Conduct all QC density gauge testing the same day that the mix being tested is placed and compacted. Obtain all core samples no later than the beginning of the next production day, not to exceed 3 calendar days. Test QC core samples and submit test results within one working day of the time the samples are taken. If the specified density tests will not be completed within the allowable time, cease production at that point until such time the required tests are completed. Failure to provide samples may result in suspension of all project operations.

Retain QC density core samples at the plant site for 5 calendar days, commencing the day the samples are tested, or until permission for disposal is granted by the QA personnel, whichever occurs first. Retain the Department's QA comparison and verification core samples in a sealed container at the plant site until obtained by QA personnel. Store all retained density samples on a smooth, flat surface in a cool, dry and protected location.

Check core samples may be taken by the Contractor for any of the following reasons:

- (1) When core sample control is being used and a test section core sample(s) is more than 2.0% below the average of all core samples from the same lot, that core(s) samples may be checked,
- (2) When a control strip fails and a core sample(s) is more than 2.0% below the average of the control strip, that core(s) may be checked.

For each core sample that is to be checked, take 3 check samples as follows: one adjacent to the initial sample and one 10 ft in each direction, longitudinally, from the initial sample. The results of these 3 check samples will be averaged, and this average will be used instead of the initial core results in question. The initial core sample results will not be used if check samples are taken.

Section 609

1 Check samples shall be taken within 2 calendar days of the date of the initial sample.
2 Only one set of check samples per sample location will be allowed. If full depth cores
3 are necessary at these check sample locations, separation of the layer to be tested will be
4 the responsibility of the Contractor. Take all check samples in the presence of
5 a representative of the Engineer. In addition, a QA comparison core sample(s) may be
6 taken adjacent to one or more of these check samples.

7 (B) Pavement Samples (Cores)

8 When cored samples are required by either density method, obtain cores from the full
9 layer depth of the compacted pavement at random locations determined in accordance
10 with procedures in the *HMA/QMS Manual*. If full depth cores are taken, the Contractor is
11 responsible for separating the layer of mix to be tested so it is not damaged. The use of
12 a separator medium beneath the layer to be tested is prohibited.

13 Obtain core samples and repair the existing pavement as outlined in Section 10.4 of the
14 *HMA/QMS Manual*.

15 (C) Core Sample Density Procedures

16 In addition to the above requirements, perform core sample density control procedures as
17 noted herein. When cored sample control is being used, the testing frequency will be
18 a minimum of one random 6" core sample taken from each test section, except take
19 a minimum of at least 3 core samples from each mix type and/or lot placed on a given
20 day.

21 An initial control strip is not required at the beginning of placement of each JMF but may
22 be performed by the Contractor for use in determining the necessary compactive effort
23 and roller patterns. Cored sample control strips will be required if production and
24 placement is being performed under limited production procedures due to failing
25 densities.

26 (D) Density Gauge Procedures

27 In addition to the requirements in Subarticle 609-7(A) perform density gauge control
28 procedures in accordance with the *Density Gauge Operator's Manual*. This manual may
29 be obtained through the Materials and Tests Soils Laboratory. Furnish an operator
30 certified by the Department.

31 Provide a gauge calibrated within the previous 12 months by an approved calibration
32 service. Maintain documentation of such calibration service for a 12 month period.

33 (E) Limited Production Procedures

34 Define "resurfacing" as the first new uniform layer placed on an existing pavement.
35 Proceed on limited production when, for the same mix type and on the same contract, one
36 of the following conditions occur (except as noted below).

37 (1) Two consecutive failing lots, except on resurfacing,

38 (2) Three consecutive failing lots on resurfacing, or

39 (3) Two consecutive failing density gauge control strips.

40 As exceptions to the above, pavement within each construction category (New and
41 Other), as defined in Article 610-13, and pavement placed simultaneously by multiple
42 paving crews will be evaluated independently for limited production purposes.

43 Limited production is defined as being restricted to the production, placement and
44 compaction of a sufficient quantity of mix necessary to construct only a 300 ft control
45 strip plus 100 ft of pavement adjacent to each end of the control strip.

1 Remain on limited production until such time as satisfactory density results are achieved
 2 or until 2 control strips have been attempted without achieving acceptable density test
 3 results. If the Contractor fails to achieve satisfactory density after 2 control strips have
 4 been attempted, cease production of that mix type until such time as the cause of the
 5 failing density test results can be determined. As an exception, the Engineer may grant
 6 approval to produce a different mix design of the same mix type if the cause is related to
 7 mix problem(s) rather than compaction related problems.

8 If the Contractor does not operate by the limited production procedures when conditions
 9 as specified in Subarticles 609-7(E)(1) to 609-7(E)(3) occur, all mix produced thereafter
 10 will be unacceptable. Remove this material and replace with material that complies with
 11 the *Standard Specifications*, unless otherwise approved.

12 **609-8 CONTRACTOR QUALITY CONTROL DOCUMENTATION (RECORDS)**

13 Document all QC activities, records of inspection, samples taken, adjustments to the mix and
 14 test results on a daily basis. Note the results of observations and records of inspection as they
 15 occur in a permanent field record. Record adjustment to mix production and test results on
 16 forms provided. Process control sample test results are for the Contractor's informational
 17 purposes only.

18 Make all such records available to the Engineer, upon request, at any time during project
 19 construction. Complete and maintain all QC records and forms and distribute in accordance
 20 with the *HMA/QMS Manual*. Submit data electronically using the Department's software.
 21 Failure to maintain QC records and forms as required, or to provide these records and forms
 22 to the Engineer upon request, may result in production stoppage, placement stoppage, removal
 23 from the NCDOT Certified Asphalt Laboratory List and removal from the NCDOT Certified
 24 Asphalt Plant List until the problem is resolved.

25 Falsification of test results, documentation of observations, records of inspection, adjustments
 26 to the process, discarding of samples and/or test results or any other deliberate
 27 misrepresentation of the facts will result in the revocation of the applicable person's
 28 QMS certification. The Engineer will determine acceptability of the mix and/or pavement
 29 represented by the falsified results or documentation. If the mix and/or pavement in question
 30 is determined to be acceptable, the Engineer may allow the mix to remain in place at no pay
 31 for the mix, asphalt binder and other mix components. If the mix or pavement represented by
 32 the falsified results is determined not to be acceptable, remove and replace with mix, that
 33 complies with the *Standard Specifications*.

34 **609-9 QUALITY ASSURANCE**

35 The Department's QA program will be conducted by a certified QMS technician(s) and will
 36 be accomplished in the following ways:

37 **(A) Plant Mix Quality Assurance**

- 38 (1) By conducting assurance testing of split samples obtained by the Contractor at
 39 a frequency equal to or greater than 5% of the frequency required of the Contractor;
- 40 (2) By periodically observing sampling and testing procedures performed by the
 41 Contractor;
- 42 (3) By monitoring required control charts exhibiting test results of control parameters;
- 43 (4) By directing the Contractor to take additional samples at any time and any location
 44 during production (instead of the next scheduled random sample for that increment);
- 45 (5) By conducting verification sampling and testing on samples taken independently of
 46 the Contractor's QC samples; at a frequency equal to or greater than 10% of the
 47 QC sample frequency; or
- 48 (6) By any combination of the above.

Section 609

1 The Engineer will periodically obtain QA and verification mix samples for testing
2 independently of the Contractor's QC process. The Engineer will conduct assurance tests
3 on both split QC samples taken by the Contractor and verification samples taken by the
4 Department. These samples may be the regular QC samples, a sample selected by the
5 Engineer from any location in the process or verification samples taken at random by the
6 Department. The Engineer may select any or all split samples for assurance testing.

7 (B) Density Quality Assurance

8 (1) By retesting randomly selected QC test sections (either cores or gauge) at
9 a frequency equal to or greater than 5% of the frequency required of the Contractor.

10 (2) By periodically observing tests performed by the Contractor;

11 (3) By testing randomly selected comparison core samples taken adjacent to the
12 Contractor's QC core samples (8" center-to-center) at a frequency equal to or greater
13 than 5% of the frequency required of the Contractor; and

14 (4) By conducting verification sampling and testing on test sections (either core or
15 gauge) independently of the Contractor's QC test sections at a frequency equal to or
16 greater than 10% of the QC sample frequency.

17 (5) By periodically directing the recalculation of random locations for the QC core or
18 density gauge test sites. The original QC test locations may be tested by
19 QA personnel and evaluated as verification tests.

20 (6) By retesting QC core samples from control strips (either core or gauge) at
21 a frequency of 100% of the frequency required of the Contractor;

22 (7) By observing the Contractor perform all standard counts of the QC gauge before
23 usage each density testing day; or

24 (8) By any combination of the above.

25 Comparison and verification core samples will be taken in the presence of a Department
26 technician, and either delivered directly to the appropriate QA Laboratory by
27 a Department technician or placed in a sealed container and delivered to the Contractor's
28 QC Laboratory for QA personnel to obtain.

29 Results of QA tests for plant mix and density will be provided to the Contractor within
30 3 working days after the sample has been obtained, except for verification TSR test
31 results that will be provided within 7 calendar days.

1 **(C) Limits of Precision**

2 Differences between the Contractor's and the Department's split sample test results will
3 be acceptable if within the limits of precision in Table 609-3.

Mix Property	Limits of Precision
25.0 mm sieve (Base Mix)	± 10.0%
19.0 mm sieve (Base Mix)	± 10.0%
12.5 mm sieve (Intermediate Mix)	± 6.0%
9.5 mm sieve (Surface Mix)	± 5.0%
4.75 mm sieve (Surface Mix)	± 5.0%
2.36 mm sieve (All Mixes)	± 5.0%
0.075 mm sieve (All Mixes)	± 2.0%
Asphalt Binder Content	± 0.5%
Maximum Specific Gravity (G_{mm})	± 0.020
Bulk Specific Gravity (G_{mb})	± 0.030
TSR	± 15.0%
QA retest of prepared QC Gyratory Compacted Volumetric Specimens	± 0.015
Retest of QC Core Sample	± 1.2% (% Compaction)
Comparison QA Core Sample	± 2.0% (% Compaction)
QA Verification Core Sample	± 2.0% (% Compaction)
Density Gauge Comparison of QC Test	± 2.0% (% Compaction)
QA Density Gauge Verification Test	± 2.0% (% Compaction)

4 The Engineer will immediately investigate the reason for differences if any of the
5 following occur: QA test results of QC split sample does not meet above limits of
6 precision, QA test results of QC split sample does not meet the individual test control
7 limits or the specification requirements or QA verification sample test results exceed the
8 allowable retesting tolerances.

9 If the potential for a pavement failure exist, the Engineer may suspend production,
10 wholly or in part, in accordance with Article 108-7 while the investigation is in progress.
11 The Engineer's investigation may include, but not be limited to joint testing of any
12 remaining split samples, review and observation of the QC technician's sampling and
13 testing procedures, evaluation and calibration of QC testing equipment, and comparison
14 testing of other retained QC samples and additional density core samples.

15 If additional mix samples or core samples are necessary to resolve the difference, these
16 samples will be taken as directed and tested jointly by the Contractor's QC personnel and
17 the Department's QA personnel. If reasons for the difference cannot be determined,
18 payment for the mix in question will be determined in accordance with Article 105-3. If
19 the reason for the difference is determined to be an error or other discrepancy in the
20 QC test results, the applicable QA test results or verification test results will be used to
21 determine compliance with the applicable mix or density specification requirements.

22 The Engineer will periodically witness the sampling and testing being performed by the
23 Contractor. If the Engineer observes that the sampling and QC tests are not being
24 performed in accordance with the applicable test procedures, the Engineer may stop
25 production until corrective action is taken. The Engineer will promptly notify the
26 Contractor of observed deficiencies, both verbally and in writing. The Engineer will
27 document all witnessed samples and tests.

Section 610

1 609-10 ACCEPTANCE

2 Final acceptance of the asphalt pavement will be made by the Department in accordance with
3 the following:

4 (A) Mix Acceptance

5 The Engineer will base final acceptance of the mix on the results of random testing made
6 on split samples during the QA process and validation of the Contractor's QC process as
7 outlined in Articles 609-6 and 609-7.

8 (B) Density Acceptance

9 The Department will evaluate the asphalt pavement for density compliance after the
10 asphalt mix has been placed and compacted using the Contractor's QC test results, the
11 Department's QA test results and by observation of the Contractor's density QC process
12 as outlined in Articles 609-7 and 610-14.

13 609-11 MEASUREMENT AND PAYMENT

14 Any mix produced that is not verified may be assessed a price reduction at the Engineer's
15 discretion in addition to any reduction in pay due to mix or density deficiencies.

16 Produce and construct all asphalt mixtures and pavements in accordance with these *Standard*
17 *Specifications*. There will be no direct payment for work covered by this Specification.
18 Payment at the contract unit prices for the various asphalt items will be full compensation for
19 all work covered by these specifications.

20 If the mix or pavement represented by the falsified results is removed and replaced, payment
21 will be made for the actual quantities of materials required to replace the falsified quantities,
22 not to exceed the original amounts.

23 SECTION 610

24 ASPHALT CONCRETE PLANT MIX PAVEMENTS

25 610-1 DESCRIPTION

26 Perform the work covered by this section including, but not limited to, the construction of one
27 or more courses of asphalt mixture placed on a prepared surface in accordance with these
28 Specifications and in reasonably close conformity with the lines, grades, thickness and typical
29 sections shown on the plans. This work includes producing, weighing, transporting, placing
30 and compacting the plant mix; furnishing aggregate, asphalt binder, anti-strip additive and all
31 other materials for the plant mix; furnishing and applying tack coat as specified; furnishing
32 scales; maintaining the course until final acceptance of the project; making any repairs or
33 corrections to the course that may become necessary; providing and conducting QC as
34 specified in Section 609; and surface testing of the completed pavement. The design
35 requirements for the various mix types are given in Section 610 for Superpave mix types,
36 Section 650 for OGAFc, Section 652 for PADC and Section 661 for UTBWC.

37 Provide and conduct the QC and required testing for acceptance of the asphalt mixture in
38 accordance with Section 609.

39 Define "warm mix asphalt (WMA)" as additives or processes that allow a reduction in the
40 temperature at which asphalt mixtures are produced and placed. WMA is allowed for use at
41 the Contractor's option when shown in the contract or as approved by the Engineer.

42 610-2 MATERIALS

43 Refer to Division 10.

Item	Section
Anti-Strip Additives	1012-1(G)
Asphalt Binder, Performance Grade	1020-2

Item	Section
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)
Mineral Filler	1012-1(D)
Reclaimed Asphalt Pavement (RAP)	1012-1(F)
Reclaimed Asphalt Shingles (RAS)	1012-1(E)
Silicone	1012-1(H)

1 Use only WMA additives or processes listed on the NCDOT Approved Product List
2 maintained by the Materials and Tests Unit.

3 **610-3 COMPOSITION OF MIXTURES (MIX DESIGN AND JOB MIX FORMULA)**

4 **(A) Mix Design-General**

5 Prepare the asphalt mix design using a mixture of coarse and fine aggregate, asphalt
6 binder, mineral filler and other additives when required. Size, uniformly grade and
7 combine the several aggregate fractions in such proportions that the resulting mixture
8 meets the grading and physical requirements of the Specifications for the specified mix
9 type. Materials that will not produce a mixture within the design criteria required by the
10 Specifications will be rejected, unless otherwise approved.

11 At least 10 days before start of asphalt mix production, submit, in writing and in
12 electronic form, the mix design and proposed JMF targets for each required mix type and
13 combination of aggregates to the Engineer for review and approval. Prepare the mix
14 design using a Department certified mix design technician in an approved mix design
15 laboratory and in accordance with the procedures outlined in Section 4.5 of the
16 *HMA/QMS Manual*.

17 For the final surface layer of the specified mix type, use a mix design with an aggregate
18 blend gradation above the maximum density line on the 2.36 mm and larger sieves.

19 Reclaimed Asphalt Pavement (RAP) or Reclaimed Asphalt Shingles (RAS) may be
20 incorporated into asphalt plant mixes in accordance with Article 1012-1 and the
21 following applicable requirements.

22 RAP may constitute up to 50% of the total material used in recycled mixtures, except for
23 mix types S12.5D, S9.5D and mixtures containing RAS. RAS material may constitute up
24 to 6% by weight of total mixture for any mix. When both RAP and RAS are used, do not
25 use a combined percentage of RAS and RAP greater than 20% by weight of total mixture,
26 unless otherwise approved. When the percent of binder contributed from RAS or
27 a combination of RAS and RAP exceeds 20% but not more than 30% of the total binder
28 in the completed mix, the virgin binder PG grade shall be one grade below (both high and
29 low temperature grade) the binder grade specified in Table 610-3 for the mix type, unless
30 otherwise approved. When the percent of binder contributed from RAS or a combination
31 of RAS and RAP exceeds 30% of the total binder in the completed mix, the Engineer will
32 establish and approve the virgin binder PG grade. Use approved methods to determine if
33 any binder grade adjustments are necessary to achieve the performance grade for the
34 specified mix type.

35 For type S12.5D and S9.5D mixes, the maximum percentage of reclaimed asphalt
36 material is limited to 20% and shall be produced using virgin asphalt binder
37 grade PG 76-22. For all other recycled mix types, the virgin binder PG grade shall be as
38 specified in Table 610-4 for the specified mix type.

39 When the percentage of RAP is greater than 20% but not more than 30% of the total
40 mixture, use RAP meeting the requirements for processed or fractionated RAP in
41 accordance with Section 1012-1.

Section 610

1 When the percentage of RAP is greater than 30% of the total mixture, use an approved
2 stockpile of RAP in accordance with Subarticle 1012-1(C). Use approved test methods to
3 determine if any binder grade adjustments are necessary to achieve the performance
4 grade for the specified mix type. The Engineer will establish and approve the virgin
5 asphalt binder grade to be used.

6 If a change in the source of RAP or RAS be made, a new mix design and JMF may be
7 required in accordance with Article 1012-1. Samples of the completed recycled mixture
8 may be taken by the Department on a random basis to determine the PG grading on the
9 recovered asphalt binder in accordance with AASHTO M 320. If the grading is
10 determined to be a value other than required for the specified mix type, the Engineer may
11 require the Contractor to adjust any combination of the grade, the percentage of
12 additional asphalt binder or the blend of reclaimed material to bring the grade to the
13 specified value.

14 (B) Mix Design Criteria

15 Design and produce asphalt concrete mixtures that conform to the gradation requirements
16 and design criteria in Table 610-2 and Table 610-3 for the mix type specified. The mix
17 type designates the nominal maximum aggregate size and the design traffic level.

18 Surface mix designs will be tested by the Department for rutting susceptibility. Rut depth
19 requirements for each surface mix type and traffic level are specified in Table 610-3.
20 Mix designs that fail to meet these requirements will be unacceptable and shall be
21 redesigned by the Contractor such that rut depths are acceptable.

22 Table 610-2 provides gradation control points to be adhered to in the development of the
23 design aggregate structure for each mix type. Aggregate gradations shall be equal to or
24 pass between the control points, unless approved in writing. Table 610-2 provides the
25 mix design criteria for the various mix types.

26 Use an anti-strip additive in all Superpave asphalt mixes. It may be hydrated lime or
27 a chemical additive or a combination of both as needed to meet the retained strength
28 requirements as specified in Table 610-3. When a chemical additive is used, add at a rate
29 of not less than 0.25% by weight of binder in the mix. When hydrated lime is used, add
30 at a rate of not less than 1.0% by weight of the total dry aggregate.

31 When WMA is used, submit the mix design without including the WMA technology.

32 (C) Job Mix Formula (JMF)

33 Establish the JMF gradation target values within the design criteria specified for the
34 particular type of asphalt mixture to be produced. Establish the JMF asphalt binder
35 content at the percentage that will produce voids in total mix (VTM) at the midpoint of
36 the specification design range for VTM, unless otherwise approved. The formula for
37 each mixture will establish the following: blend percentage of each aggregate fraction,
38 the percentage of reclaimed aggregate, if applicable, a single percentage of combined
39 aggregate passing each required sieve size, the total percentage and grade of asphalt
40 binder required for the mixture (by weight of total mixture), the percentage and grade of
41 asphalt binder to be added to the mixture (for recycled mixtures), the percentage of
42 chemical anti-strip additive to be added to the asphalt binder or percentage of hydrated
43 lime to be added to the aggregate, the temperature at that the mixture is to be discharged
44 from the plant, the required field density and other volumetric properties.

45 When WMA is used, document the additive or process used and recommended rate on
46 the JMF submittal. Verify the JMF based on plant produced mixture from the trial batch.

47 The mixing temperature at the asphalt plant will be established on the JMF. Unless
48 otherwise requested, refer to Table 610-1 to establish the JMF temperature.

Binder Grade	JMF Temperature
PG 64-22	300°F
PG 70-22	315°F
PG 76-22	335°F

1 When using RAP or RAS with a different binder than specified, use mixing and
2 compaction temperatures in Table 610-1 based on the original binder grade for that mix
3 type shown in Table 610-3.

4 When WMA is used, the Asphalt Design Engineer (after consultation with the
5 Contractor) will set the mixing temperature at the plant within the allowable temperature
6 range of 225°F to 275°F. When WMA is used in conjunction with RAS, the Asphalt
7 Design Engineer will set the mixing temperature at 275°F.

8 Have on hand at the asphalt plant the approved mix design and JMF issued by the
9 Department, before beginning the work.

10 The JMF for each mixture will remain in effect until modified in writing, provided the
11 results of QMS tests performed in accordance with Section 609 on material currently
12 being produced conform with specification requirements. When a change in sources of
13 aggregate materials is to be made, a new mix design and JMF will be required before the
14 new mixture is produced, unless otherwise approved. When a change in sources of RAP
15 or RAS material is to be made, a new mix design and/or JMF may be required in
16 accordance with Article 1012-1. When unsatisfactory results or other conditions make it
17 necessary, the Engineer may revoke the existing JMF or establish a new JMF.

Standard Sieves (mm)	Mix Type (Nominal Max. Aggregate Size)							
	9.5 mm^A		12.5 mm^A		19.0 mm		25.0 mm	
	<i>Min</i>	<i>Max</i>	<i>Min</i>	<i>Max</i>	<i>Min</i>	<i>Max</i>	<i>Min</i>	<i>Max</i>
50.0	-	-	-	-	-	-	-	-
37.5	-	-	-	-	-	-	100	-
25.0	-	-	-	-	100	-	90.0	100
19.0	-	-	100	-	90.0	100	-	90.0
12.5	100	-	90.0	100	-	90.0	-	-
9.50	90.0	100	-	90.0	-	-	-	-
4.75	-	90.0	-	-	-	-	-	-
2.36	32.0 ^B	67.0 ^B	28.0	58.0	23.0	49.0	19.0	45.0
1.18	-	-	-	-	-	-	-	-
0.075	4.0	8.0	4.0	8.0	3.0	8.0	3.0	7.0

18 **A.** For the final surface layer of the specified mix type, use a mix design with
19 an aggregate blend gradation above the maximum density line on the 2.36 mm and
20 larger sieves.

21 **B.** For Type SF9.5A, the percent passing the 2.36 mm sieve shall be a minimum of 60%
22 and a maximum of 70%.

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**TABLE 610-3
SUPERPAVE MIX DESIGN CRITERIA**

Mix Type	Design ESALs ^A millions	Binder PG Grade ^B	Compaction Levels		Max. Rut Depth (mm)	Volumetric Properties			
			G _{mm} @			VMA % Min.	VTM %	VFA Min.-Max.	%G _{mm} @ N _{ini}
			N _{ini}	N _{des}					
SF9.5A	< 0.3	64 - 22	6	50	11.5	16.0	3.0 - 5.0	70 - 80	≤ 91.5
S9.5B	0.3 - 3	64 - 22	7	65	9.5	15.5	3.0 - 5.0	65 - 80	≤ 90.5
S9.5C	3 - 30	70 - 22	7	75	6.5	15.5	3.0 - 5.0	65 - 78	≤ 90.5
S9.5D	> 30	76 - 22	8	100	4.5	15.5	3.0 - 5.0	65 - 78	≤ 90.0
S12.5C	3 - 30	70 - 22	7	75	6.5	14.5	3.0 - 5.0	65 - 78	≤ 90.5
S12.5D	> 30	76 - 22	8	100	4.5	14.5	3.0 - 5.0	65 - 78	≤ 90.0
I19.0B	< 3	64 - 22	7	65	-	13.5	3.0 - 5.0	65 - 78	≤ 90.5
I19.0C	3 - 30	64 - 22	7	75	-	13.5	3.0 - 5.0	65 - 78	≤ 90.0
I19.0D	> 30	70 - 22	8	100	-	13.5	3.0 - 5.0	65 - 78	≤ 90.0
B25.0B	< 3	64 - 22	7	65	-	12.5	3.0 - 5.0	65 - 78	≤ 90.5
B25.0C	> 3	64 - 22	7	75	-	12.5	3.0 - 5.0	65 - 78	≤ 90.0
Design Parameter					Design Criteria				
All Mix Types	Dust to Binder Ratio (P _{0.075} / P _{be})				0.6 - 1.4				
	Tensile Strength Ratio (TSR)				85% Min. ^{C,D}				

- 1 **A.** Based on 20 year design traffic.
- 2 **B.** Volumetric Properties based on specimens compacted to N_{des} as modified by the
- 3 Department.
- 4 **C.** TSR for Type B 25.0 and Type B 25.0C mixes is 80% minimum.
- 5 **D.** AASHTO T 283 Modified (No Freeze-Thaw cycle required).

**TABLE 610-4
SUPERPAVE APPLICABLE VIRGIN ASPHALT GRADES**

Mix Type	Percentage of RAP in Mix		
	Category 1 ^A	Category 2 ^B	Category 3 ^C
	% RAP ≤ 20%	21% ≤ % RAP ≤ 30%	% RAP > 30%
All A and B Level Mixes, I19.0C, B25.0C	PG 64-22	PG 64-22	Established by Engineer
S9.5C, S12.5C, I19.0D	PG 70-22	PG 64-22	Established by Engineer
S9.5D and S12.5D	PG 76-22	-	-

- 6 **A.** Category 1 RAP has been processed to a maximum size of 2".
- 7 **B.** Category 2 RAP has been processed to a maximum size of 1" by either crushing and
- 8 or screening to reduce variability in the gradations.
- 9 **C.** Category 3 RAP has been processed to a maximum size of 1", fractionating the RAP
- 10 into 2 or more sized stockpiles.

610-4 WEATHER, TEMPERATURE AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES

Do not produce or place asphalt mixtures during rainy weather, when the subgrade or base course is frozen or when the moisture on the surface to be paved would prevent proper bond. Do not place asphalt material when the air temperature, measured in the shade away from artificial heat at the location of the paving operation and the road surface temperature in the shade is less than the temperatures shown in Table 610-5.

Do not place surface course material that is to be the final layer of pavement between December 15 and March 16 of the next year if it is 1" or greater in thickness or between November 15 and April 1 of the next year if it is less than 1" in thickness, unless otherwise approved. Do not place open-graded asphalt friction course between October 31 and April 1 of the next year, unless otherwise approved.

1 As an exception to the above, when in any day's operations the placement of a layer of asphalt
 2 base course material or intermediate material 2" or greater in thickness has started, it may
 3 continue until the temperature drops to 32°F.

4 Do not place plant mix base course or intermediate course that will not be covered with
 5 surface course during the same calendar year or within 15 days of placement if the plant mix
 6 is placed in January or February. Failure by the Contractor to cover the plant mix as required
 7 above will result in the Engineer notifying the Contractor in writing to cover the plant mix
 8 with a sand seal. Apply the sand seal in accordance with Section 660, except that
 9 Articles 660-3 and 660-11 will not apply. In the event the Contractor fails to apply the sand
 10 seal within 72 hours of receipt of such notice, the Engineer may proceed to have such work
 11 performed with Department forces and equipment.

TABLE 610-5 PLACEMENT TEMPERATURES FOR ASPHALT		
Asphalt Concrete Mix Type	Minimum Air Temperature	Minimum Surface Temperature
B25.0B, C	35°F	35°F
I19.0B, C, D	35°F	35°F
SF9.5A, S9.5B	40°F	50°F ^A
S9.5C, S12.5C	45°F	50°F
S9.5D, S12.5D	50°F	50°F

12 A. 35°F if surface is soil or aggregate base for secondary road construction.

13 610-5 ASPHALT MIXTURE PRODUCTION

14 (A) General

15 Use plants that are either of the batch mixing, continuous mixing or drum mixing type,
 16 and so designed, equipped and operated that the weighing, proportioning and mixing of
 17 the materials will result in a uniform and satisfactory asphalt mixture meeting these
 18 Specifications. All plants shall conform to requirements of Subarticle 610-5(B) for the
 19 preparation of asphalt mixtures. In addition, batch mixing and drum mixing plants shall
 20 conform to the specific requirements of Sections 6.5 and 6.6, respectively, of the
 21 *HMA/QMS Manual*.

22 Before production of the mix, stockpile aggregates for a sufficient period of time to
 23 facilitate the drainage of free moisture. Keep the different aggregate sizes separated until
 24 they have been delivered to the cold feeders. Keep the separate stockpiles readily
 25 accessible for sampling. When mineral filler is required in the mix, feed or weigh-in
 26 separately from the other aggregates.

27 Introduce the asphalt binder and other additives, when required, into the mixture at the
 28 amounts and percentages specified by the JMF. No working tolerance will be allowed.
 29 Introduce the dried and heated aggregates and mineral filler, when required, in amounts
 30 and at temperatures such that the mixture produced is within the production control limits
 31 of Subarticle 609-6(D). Provide a positive means of controlling mixing time to obtain
 32 complete and uniform coating of the aggregate particles and thorough distribution of the
 33 asphalt binder throughout the aggregate. Produce the mixture at the asphalt plant within
 34 $\pm 15^\circ\text{F}$ of the temperature established on the JMF.

35 All asphalt plants shall be certified by the Department as meeting these *Standard*
 36 *Specifications*. Certification is effective from the date of issuance and is non-expiring
 37 subject to continued compliance. The Department will check the plant on an annual basis
 38 or as deemed necessary by the Engineer. Any plant that is relocated, modified or changes
 39 ownership shall be recertified before use.

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1 Any completely automatically controlled asphalt plant that, due to the basic design of the
2 plant, does not meet all these Specifications for conventional batch mixing, continuous
3 mixing or drum mixing may be used on a project by project basis provided a uniformly
4 consistent mix meeting all mix requirements can be produced and the plant has been
5 approved in writing.

6 **(B) Requirements for All Plants**

7 (1) Equipment for Preparation of Asphalt Binder

8 Equip tanks for the supplying of asphalt binder to the plant to uniformly heat and
9 hold the material at the required temperature before introduction into the mixer unit.
10 Provide a circulating system for asphalt materials, that is capable of the proper
11 mixing of additives. Provide a system with adequate pump or pumps to charge the
12 mixing unit and unload asphalt material simultaneously. Include provisions for
13 measuring and sampling plant supply tanks.

14 (2) Anti-Strip Additive Equipment

15 When chemical anti-strip additive is to be added to the asphalt binder at the asphalt
16 plant instead of at the terminal, equip the plant with an in-line blending system
17 capable of metering the additive within plus or minus 10% of the amount specified.
18 Provide a thermostatically controlled heating system capable of heating and
19 maintaining the additive tanks, contents and distribution system at the additive
20 supplier's recommended temperature for the additive being used. Interlock the
21 additive metering system with the asphalt binder control equipment so as to
22 automatically vary the additive feed rate to maintain the required proportions.
23 Provide a system that will automatically indicate in the plant control room the
24 amount or rate of flow, when flow is occurring and when flow is obstructed or stops.
25 Inject the additive into the asphalt binder feed line before introduction into the
26 aggregate. Equip the feed line with an in-line blending device capable of thoroughly
27 mixing the additive with the asphalt binder before mixing with the aggregate.
28 Provide a metering system capable of being calibrated, checked and monitored for
29 accuracy and amount of additive used.

30 Equip the system with an in-line totalizing flow meter capable of measuring the
31 actual quantity in gallons of anti-strip additive that is injected into the asphalt binder
32 being introduced into the aggregate. Provide a system that is capable of being easily
33 read but not capable of being reset. Install the totalizer meter in the anti-strip
34 feedline beyond the calibration bypass and as close to the actual point of additive
35 introduction into the feedline as practical.

36 When hydrated lime anti-strip additive is used, provide a separate bin or tank and
37 feeder system to store and proportion the lime into the aggregate in either dry or
38 slurry form. Mix the lime and aggregate by pugmill or other approved means to
39 achieve a uniform lime coating of the aggregate before entering the drier. When the
40 lime is added in dry form, the aggregate shall contain at least 3% free moisture. The
41 stockpiling of lime treated aggregate will not be permitted. Control the lime feeder
42 system by a proportioning device that is accurate to within $\pm 10\%$ of the specified
43 amount. Provide a proportioning device with a convenient and accurate means of
44 calibration and that is interlocked with the aggregate feed or weigh system so as to
45 maintain the correct proportion. Provide a flow indicator or sensor that is
46 interlocked with the plant controls such that production of the mixture will be
47 interrupted if there is a stoppage or reduction of the lime feed.

- 1 (3) Aggregate Cold Feed Equipment
- 2 Use cold bins and a feeder system to proportion the aggregates and feed them to the
- 3 dryer. Use separate cold bins for each size aggregate and each natural sand being
- 4 used to provide a uniform and continuous flow. Provide separate dry storage when
- 5 mineral filler is required. Equip cold aggregate bins with feeder units having
- 6 interlocking controls capable of maintaining a constant ratio between the relative
- 7 quantities of each size aggregate at varying plant production rates.
- 8 Provide cold feeders that are capable of being easily and accurately calibrated to
- 9 ensure full control of the mix gradation.
- 10 (4) Dryer
- 11 Use a plant with a dryer or dryers that continuously agitate the aggregate during the
- 12 heating and drying process.
- 13 (5) Control Unit for Asphalt Binder
- 14 Provide satisfactory means, either by weighing or metering to introduce the proper
- 15 amount of asphalt binder into the mix.
- 16 (6) Thermometric Equipment
- 17 (a) Asphalt Binder Thermometric Equipment
- 18 Provide a thermometric device of adequate temperature range fixed in the
- 19 asphalt binder feed line.
- 20 (b) Dryer Thermometric Equipment
- 21 Equip the dryer with an automatic burner control device that uses an approved
- 22 thermometric instrument located in the discharge chute to actuate the automatic
- 23 controls.
- 24 (7) Pollution Control Equipment
- 25 Equip all plants with such pollution control equipment as is necessary to meet all
- 26 applicable Federal, State and local pollution requirements. Register and certify all
- 27 plants by applicable environmental regulatory agencies before being certified by the
- 28 Department.
- 29 (8) Safety Requirements
- 30 Provide adequate safety devices at all points where accessibility to plant operations
- 31 is required. Provide accessibility to the top of truck bodies by a platform or other
- 32 suitable device to enable QC and QA personnel to obtain samples and mixture
- 33 temperature data. Thoroughly guard and protect all gears, pulleys, chains, sprockets
- 34 and other dangerous moving parts. Provide ample and unobstructed space on the
- 35 mixing platform. Maintain a clear and unobstructed passage at all times in and
- 36 around the truck loading area. Keep all work areas free from asphalt drippings.
- 37 (9) Production Consistency
- 38 Any asphalt plant that cannot consistently produce a high quality mix meeting these
- 39 Specifications will be in non-compliance with these Specifications and may have its
- 40 certification revoked.
- 41 Upon a malfunction of required automatic equipment on a batch mixing plant, the
- 42 plant may continue to operate manually for the following 2 consecutive working
- 43 days, provided acceptable mixture is being produced.

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1 When a malfunction of required automatic equipment on a drum mixer or continuous
2 plant occurs, manual operation of the plant will not be allowed except that if, in the
3 opinion of the Engineer, an emergency traffic condition exists, the plant may be
4 allowed to operate manually until the unsafe traffic condition is corrected. All mix
5 produced by manual operation will be subject to Section 609.

6 **610-6 HOT MIX STORAGE SYSTEMS**

7 When a storage system is used, provide a system capable of conveying the mix from the plant
8 to the storage bin and storing the mix without a loss in temperature, segregation or oxidation
9 of the mix. Limit storage time to the ability of the storage system to maintain the mix within
10 the Specification requirements. Material may be stored in storage bins without an approved
11 heating system for no more than 24 hours.

12 Provide a continuous type or skip bucket type conveyor system. Enclose continuous type
13 conveyors so that the mix temperature is maintained within specification requirements.
14 Provide a system designed in such manner as to prevent segregation of the mix during
15 discharge from the conveyor into the bins and equipped with discharge gates that will not
16 cause segregation of the mix while loading the mix into trucks.

17 **610-7 HAULING OF ASPHALT MIXTURE**

18 Transport the mixture from the mixing plant to the point of use in vehicles that have tight,
19 clean, smooth beds approved by the Department, that have been sprayed with an approved
20 release agent material to prevent the mixture from adhering to the beds. Remove excess
21 release agent before loading. Cover each load of mixture with a solid, waterproof tarp
22 constructed of canvas, vinyl, or other suitable material. Securely fasten each tarp so as to
23 overlap the top of the truck bed and prevent the entrance of moisture and the rapid loss of
24 temperature. Provide a 3/8" to 5/8" diameter hole on each side of the vehicle body near the
25 center of the body and above the bed of the vehicle for the purpose of inserting a
26 thermometer.

27 Assure temperature of the mixture immediately before discharge from the hauling vehicle is
28 within a tolerance of +15°F to -25°F of the specified JMF temperature.

29 **610-8 SPREADING AND FINISHING**

30 Apply tack coat in accordance with Section 605.

31 Mixtures produced simultaneously from different plant sources cannot be intermingled by
32 hauling to the same paver on the roadway unless the mixtures are being produced from the
33 same material sources and same JMF.

34 Perform this work in accordance with and using equipment meeting Section 9.5 of the
35 *HMA/QMS Manual*.

36 Use a material transfer vehicle (MTV) when placing all asphalt concrete plant mix pavements
37 which require the use of asphalt binder grade PG 76-22 and for all types of OGAFc, unless
38 otherwise approved. Use a MTV for all surface mix regardless of binder grade placed on
39 Interstate and US routes that have 4 or more lanes and median divided. Where required
40 above, use the MTV when placing all full width travel lanes and collector lanes. Use MTV
41 for all ramps, loops, Y-line travel lanes, full width acceleration lanes, full width deceleration
42 lanes and full width turn lanes that are greater than 1,000 ft in length. Use a MTV meeting
43 Section 9.5(E) of the *HMA/QMS Manual*.

44 Request the Engineer to waive the requirement for use of pavers for spreading and finishing
45 where irregularities or obstacles make their use impractical. Spread, rake and lute the mixture
46 by hand methods or other approved methods in these areas.

47 Operate the paver as continuously as possible. Pave intersections, auxiliary lanes and other
48 irregular areas after the main line roadway has been paved, unless otherwise approved.

1 Repair any damage caused by hauling equipment across structures at no additional cost to the
2 Department.

3 **610-9 COMPACTION**

4 Immediately after the asphalt mixture has been spread, struck off and surface and edge
5 irregularities adjusted, thoroughly and uniformly compact the pavement. Compact the mix to
6 the required degree of compaction for the type of mixture being placed.

7 Provide sufficient number and weight of rollers, except as noted, to compact the mixture to
8 the required density while it is still in a workable condition. Obtain approval of equipment
9 used in compaction from the Engineer before use. Where uniform density is not being
10 obtained throughout the depth of the layer of material being tested, change the type and/or
11 weight of the compaction equipment as necessary to achieve uniform density even though
12 such equipment has been previously approved.

13 Compact all final wearing surfaces, except open-graded asphalt friction course, using
14 a minimum of 2 steel-wheel tandem rollers, unless otherwise approved. Pneumatic-tire rollers
15 with 2 tandem axles and smooth tread tires may be used for intermediate rolling.

16 Limit rolling for open-graded asphalt friction course to one coverage with a tandem steel-
17 wheel roller weighing a maximum of 10 tons, with additional rolling limited to one coverage
18 with the roller where necessary to improve the riding surface.

19 Steel-wheel tandem vibratory rollers specifically designed for the compaction of asphalt
20 pavements may be used on all layers 1" or greater in thickness during the breakdown and
21 intermediate rolling phase. Do not operate vibratory rollers in the vibratory mode during the
22 finish rolling phase on any mix type or pavement course, open-graded asphalt friction course
23 or on permeable asphalt drainage course.

24 When vibratory rollers are used, use rollers that have variable amplitude and frequency
25 capabilities and that are designed specifically for asphalt pavement compaction. Provide
26 rollers equipped with controls that automatically disengage the vibration mechanism before
27 the roller stops when being used in the vibratory mode.

28 The Engineer may prohibit or restrict the use of vibratory rollers where damage to the
29 pavement being placed, the underlying pavement structure, drainage structures, utilities or
30 other facilities is likely to occur or is evident.

31 Do not use rolling equipment that results in excessive crushing of the aggregate or excessive
32 displacement of the mixture.

33 In areas inaccessible to standard rolling equipment, thoroughly compact the mixture by the
34 use of hand tampers, hand operated mechanical tampers, small rollers or other approved
35 methods.

36 Use rollers that are in good condition and capable of being reversed without backlash to
37 compact the mixture. Operate rollers with the drive wheels nearest the paver and at uniform
38 speeds slow enough to avoid displacement of the mixture. Equip steel-wheel rollers with
39 wetting devices that will prevent the mixture from sticking to the roller wheels.

40 Begin compaction of the material immediately after the material is spread and shaped to the
41 required width and depth. Carry out compaction in such a manner as to obtain uniform
42 density over the entire section. Perform compaction rolling at the maximum temperature at
43 which the mix will support the rollers without moving horizontally. Complete the compaction
44 (including both intermediate rolling) before the mixture cooling below a workable
45 temperature. Perform finish rolling to remove roller marks resulting from the compaction
46 rolling operations.

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1 610-10 DENSITY REQUIREMENTS

Superpave Mix Type	Minimum % G_{mm} (Maximum Specific Gravity)
SF9.5A	90.0
S9.5X, S12.5X, I19.0X, B25.0X	92.0

2 Compact the asphalt plant mix to at least the minimum percentage of the maximum specific
3 gravity listed in Table 610-6, except as noted below. Perform density sampling and testing on
4 all pavements listed below unless otherwise approved:

5 (A) Full width travel lane pavements, including normal travel lanes, turn lanes, collector
6 lanes, ramps and loops and temporary pavements;

7 (B) Pavement widening 4.0 ft or greater;

8 (C) Uniform width paved shoulders 2.0 ft or greater; and

9 (D) Wedging as outlined in the *HMA/QMS Manual*.

10 Compact base and intermediate mix types (surface mixes not included) used for pavement
11 widening of less than 4.0 ft and all mix types used in tapers, irregular areas and intersections
12 (excluding full width travel lanes of uniform thickness), using equipment and procedures
13 appropriate for the pavement area width and/or shape. Compaction with equipment other than
14 conventional steel drum rollers may be necessary to achieve adequate compaction.
15 Occasional density sampling and testing to evaluate the compaction process may be required.
16 Densities lower than that specified in Table 610-6 may be accepted, in accordance with
17 Article 105-3, for the specific mix types and areas listed directly above.

18 610-11 JOINTS

19 (A) Transverse Joints

20 When the placing of the mixture is to be suspended long enough to permit the mixture to
21 become chilled, construct a transverse joint.

22 If traffic will not pass over the end of the paving, a butt joint will be permitted, provided
23 proper compaction is achieved. If traffic will pass over the joint, construct a sloped
24 wedge ahead of the end of the full depth pavement to provide for proper compaction and
25 protection of the full depth pavement. Construct the joint square to the lane alignment
26 and discard all excess material. Place a paper parting strip beneath this wedge to
27 facilitate joint construction unless waived by the Engineer.

28 Before paving operations are resumed, remove the sloped wedge and cut back into the
29 previously constructed pavement to the point of full pavement depth. Coat the exposed
30 edge of the previously constructed pavement with tack coat.

31 When laying of the mixture is resumed at the joint, complete and then test the
32 construction of the joint in accordance with Article 610-12 while the mixture is still in
33 a workable condition.

34 (B) Longitudinal Joints

35 Tack the exposed edge of all longitudinal joints before placing the adjoining pavement.

36 Form longitudinal joints by allowing the paver to deposit the mixture adjacent to the joint
37 to such depth that maximum compaction can be obtained along the joint. Pinch the joint
38 by rolling immediately behind the paver.

1 When multi-lane multi-layer construction is required, offset the longitudinal joints in
2 each layer from that in the layer immediately below by approximately 6". Construct the
3 joints in the final layer, where possible, between designated travel lanes of the final
4 traffic pattern.

5 **610-12 SURFACE REQUIREMENTS AND ACCEPTANCE**

6 Construct pavements using quality-paving practices as detailed herein. Construct the
7 pavement surface smooth and true to the plan grade and cross slope. Immediately correct any
8 defective areas with satisfactory material compacted to conform with the surrounding area.

9 Pavement imperfections resulting from unsatisfactory workmanship such as segregation,
10 improper longitudinal joint placement or alignment, non-uniform edge alignment or excessive
11 pavement repairs will be unsatisfactory. Pavement imperfections will be evaluated for
12 acceptance in accordance with Article 105-3.

13 When directed due to unsatisfactory laydown or workmanship, operate under the limited
14 production procedures. Limited production for unsatisfactory laydown is defined as being
15 restricted to the production, placement, compaction and final surface testing (if applicable) of
16 a sufficient quantity of mix necessary to construct only 2,500 ft of pavement at the laydown
17 width.

18 Remain on limited production until such time as satisfactory laydown results are obtained or
19 until 3 consecutive 2,500 ft sections have been attempted without achieving satisfactory
20 laydown results. If the Contractor fails to achieve satisfactory laydown results after
21 3 consecutive 2,500 ft sections have been attempted, cease production of that mix type until
22 such time as the cause of the unsatisfactory laydown results can be determined.
23 As an exception, the Engineer may grant approval to produce a different mix design of the
24 same mix type if the cause is related to mix problems rather than laydown procedures.

25 Mix placed under the limited production procedures for unsatisfactory laydown or
26 workmanship will be evaluated for acceptance in accordance with Article 105-3.

27 Each pavement layer will be tested by the Contractor and the Engineer using a 10-ft stationary
28 straightedge furnished by the Contractor. Any location on the pavement selected by the
29 Department shall be tested as well as all transverse joints. Apply the straightedge parallel to
30 the centerline of the surface. Do not exceed 1/8" variation of the surface being tested from
31 the edge of the straightedge between any 2 contact points. Correct areas found to exceed this
32 tolerance by removal of the defective work and replacement with new material, unless other
33 corrective measures are permitted. Provide the work and materials required in the correction
34 of defective work.

35 **610-13 FINAL SURFACE TESTING AND ACCEPTANCE**

36 On portions of this project where the typical section requires two or more layers of new
37 pavement, perform smoothness acceptance testing of the longitudinal profile of the finished
38 pavement surface using either an Inertial Profiler or a North Carolina Hearne Straightedge
39 (Model No. 1).

40 Use an Inertial Profiler (Option 1) to perform smoothness acceptance testing of the
41 longitudinal profile of the finished pavement surface. Furnish an inertial profiler(s) necessary
42 to perform this work. Maintain responsibility for all costs related to the procurement,
43 handling, and maintenance of these devices.

44 Furnish and operate the Hearne straightedge (Option 2) to determine and record the
45 longitudinal profile of the pavement on a continuous graph.

46 Before beginning any paving operations, the Contractor shall select one of the above options
47 and submit documentation to the Engineer on the selected option for smoothness acceptance.

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1 (A) Option 1 - Inertial Profiler

2 Use an Inertial Profiler to measure the longitudinal pavement profile for construction
3 quality control and smoothness acceptance. Use a profiler with line laser technology as
4 single-point laser technology will not be allowed. Produce International Roughness
5 Index (IRI) and Mean Roughness Index (MRI) values for measuring smoothness.

6 Use testing and recording software to produce electronic inertial road profiles in a format
7 compatible with the latest version of FHWA's ProVAL (Profile Viewing and Analysis)
8 software.

9 The Inertial Profiler shall be calibrated and verified in accordance with the most current
10 version of AASHTO M 328. Provide certification documentation that the profiler meets
11 AASHTO M 328 to the Engineer before the first day the Inertial Profiler is used on the
12 project.

13 Configure the profiler to record the actual elevation of the pavement surface. Do not use
14 the profiler's internal IRI calculation mode. The profile data shall be filtered with
15 a cutoff wavelength of 300 ft. The interval at which relative profile elevations are
16 reported shall be 1".

17 Provide IRI data in accordance with most current version of ASTM E1926. Use
18 personnel trained to record and evaluate IRI data.

19 Provide a competent operator, trained in the operation of the Inertial Profiler Operation of
20 the Inertial Profiling system shall conform to AASHTO R 57.

21 Provide the user selected Inertial Profiler settings to the Engineer for the project records.
22 Certification of the Inertial Profiling system shall conform to AASHTO R 56.

23 Remove all objects and foreign material on the pavement surface prior to longitudinal
24 pavement profile testing.

25 Operate the profiler at any speed as per the manufacturer's recommendations, however,
26 the speed must be constant to within ± 3 mph of the intended speed and any required
27 acceleration should be as gradual as possible. For example, if the intended speed were
28 30 mph, the acceptable range of speed for testing would be 27 to 33 mph.

29 Operate the Inertial Profiler in the direction of the final traffic pattern. Collect IRI data
30 from both wheel paths during the same run. It is permissible to collect data one wheel
31 path at a time if each wheel path is tested and evaluated separately. Define a "wheel
32 path" as the 3 ft from the edge of the travel lane. MRI values are the average of the IRI
33 values from both wheel paths. When using an inertial profiler that collects a single trace
34 per pass, take care to ensure that the measurements from each trace in a travel lane start
35 and stop at the same longitudinal locations. Unless otherwise specified, multiple runs are
36 not necessary for data collection.

37 Operate the automatic triggering method at all times unless impractical. A tape stripe or
38 traffic cone wrapped with reflective material may be used to alert the profiler's automatic
39 triggering sensor to begin data collection. The profiler shall reach the intended operating
40 speed before entering the test section. The runup and runout distances should be
41 sufficient to obtain the intended operating speed and to slow down after testing is
42 completed.

43 Divide the pavement surface for the project into sections which represent a continuous
44 placement (i.e. the start of the project to bridge, intersection to intersection). Terminate
45 a section 50 ft before a bridge approach, railroad track, or similar interruption. (Separate
46 into 0.10-mile sections).

47 The evaluation of the profiles will be performed on a section basis. A section is 0.10
48 mile of a single pavement lane. For any section, which is less than 0.10 mile in length,
49 the applicable pay adjustment incentive will be prorated on the basis of the actual length.

1 Mark the limits of structures and other special areas to be excluded from testing using the
2 profiler's event identifier such that the exact locations can be extracted from the profile
3 data file during processing.

4 Unless otherwise authorized by the Engineer, perform all smoothness testing in the
5 presence of the Engineer. Perform smoothness tests on the finished surface of the
6 completed project or at the completion of a major stage of construction as approved by
7 the Engineer. Coordinate with and receive authorization from the Engineer before
8 starting smoothness testing. Perform smoothness tests within 7 days after receiving
9 authorization. Any testing performed without the Engineer's presence, unless otherwise
10 authorized, may be ordered retested at the Contractor's expense.

11 After testing, transfer the profile data from the profiler portable computer's hard drive to
12 a write once storage media (DVD-R or CD-R) or electronic media approved by the
13 Engineer. Label the disk or electronic media with the Project number, Route, file
14 number, date, and termini of the profile data. Submit the electronic data on the approved
15 media to the Engineer immediately after testing and this media will not be returned to the
16 Contractor.

17 Submit documentation and electronic data of the evaluation for each section to the
18 Engineer within 10 days after completion of the smoothness testing. Submit the
19 electronic files compatible with ProVAL and the evaluation in tabular form with each
20 0.10 mile segment occupying a row. Include each row with the beginning and ending
21 station for the section, the length of the section, the original IRI values from each wheel
22 path, and the MRI value for the section. Each continuous run for a section will occupy a
23 separate table and each table will have a header that includes the following: the project
24 contract number, county, the roadway number or designation, a lane designation, the JMF
25 used for the final lift, the dates of the smoothness runs, and the beginning and ending
26 station of the continuous run. Summarize each table at the bottom.

27 Traffic control and all associated activities included in the pavement smoothness testing
28 of the pavement surface will be the responsibility of the Contractor.

29 (1) Acceptance for New Construction

30 IRI and MRI numbers recorded in inches per mile will be established for each
31 0.10-mile section for each travel lane of the surface course designated by the
32 contract. Areas excluded from testing by the profiler will be tested using
33 a 10-ft straightedge in accordance with Article 610-12.

34 Table 610-7 provides the acceptance quality rating scale of pavement based on the
35 final rideability determination.

TABLE 610-7	
MRI PRICE ADJUSTMENT PER 0.10-MILE SECTION	
MRI after Completion (Inches Per Mile)	Price Adjustment Per Lane (0.10-Mile Section)
45.0 and Under	\$200.00
45.1-55.0	PA = 600 – (10 * MRI)
55.1-70.0	Acceptable (No Pay Adjustment)
70.1-90.0	PA = 650 – (10 * MRI)
Over 90.1	Corrective Action Required

36 This price adjustment will apply to each 0.10-mile section based on the Mean
37 Roughness Index (MRI), the average IRI values from both wheel paths.

38 When corrections to the pavement surface are required, the Engineer shall approve
39 the Contractor's method of correction. Methods of correction shall be milling and
40 inlay, remove and replace or other methods approved by the Engineer. To produce
41 a uniform cross section, the Engineer may require correction to the adjoining traffic

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lanes or shoulders. Corrections to the pavement surface, the adjoining traffic lanes and shoulders will be at no cost to the Department.

Where corrections are made after the initial smoothness testing, the pavement will be retested by the Contractor to verify that corrections have produced the acceptable ride surface. No incentives will be provided for sections on which corrective actions have been required. The Contractor will have one opportunity to perform corrective action(s).

(2) Localized Roughness

Areas of localized roughness shall be identified through the “Smoothness Assurance Module” provided in the ProVAL software. Use the “Smoothness Assurance Module” to optimize repair strategies by analyzing the measurements from profiles collected using inertial profilers. The ride quality threshold for localized roughness shall be 125"/mile at the continuous short interval of 25 ft. Submit a continuous roughness report to identify sections outside the threshold and identify all localized roughness, with the signature of the Operator included with the submitted IRI trace and electronic files.

The Department will require that corrective action be taken regardless of final IRI. Re-profile the corrected area to ensure that the corrective action was successful. If the corrective action is not successful, the Department will assess a penalty or require additional corrective action.

Corrective work for localized roughness shall be approved by the Engineer before performing the work and shall consist of either replacing the area by milling and inlaying or other methods approved by the Engineer. Any corrective action performed shall not reduce the integrity or durability of the pavement that is to remain in place. Milling and inlay or any corrective actions shall meet the specifications requirements for ride quality over the entire length of the correction. Notify the Engineer 5 days before commencement of the corrective action.

Localized roughness correction work shall be for the entire traffic lane width. Pavement cross slope shall be maintained through corrective areas.

(B) Option 2 - North Carolina Hearne Straightedge

Push the straightedge manually over the pavement at a speed not exceeding 2 mph. For all lanes, take profiles in the right wheel path approximately 3 ft from the right edge of pavement in the same direction as the paving operation, unless otherwise approved due to traffic control or safety considerations. As an exception, lanes adjacent to curb and gutter, expressway gutter, or shoulder berm gutter may be tested in the left wheel path. Make one pass of the straightedge in each full width travel lane. The full lane width should be comparable in ride quality to the area evaluated with the Hearne Straightedge. If deviations exist at other locations across the lane width, use a 10-ft non-mobile straightedge or the Hearne Straightedge to evaluate which areas may require corrective action. Take profiles as soon as practical after the pavement has been rolled and compacted, but no later than 24 hours following placement of the pavement, unless otherwise authorized by the Engineer. Take profiles over the entire length of final surface travel lane pavement exclusive of Y-line travel lanes less than or equal to 1,000 ft in length, ramps less than or equal to 1,000 ft in length, turn lanes less than or equal to 1,000 ft in length, structures, approach slabs, paved shoulders, loops and tapers or other irregular shaped areas of pavement, unless otherwise approved by the Engineer. Test in accordance with this provision all mainline travel lanes, full width acceleration or deceleration lanes, Y-line travel lanes greater than 1,000 ft in length, ramps, full width turn lanes greater than 1,000 ft in length and collector lanes.

1 At the beginning and end of each day's testing operations, and at such other times as
2 determined by the Engineer, operate the straightedge over a calibration strip so that the
3 Engineer can verify correct operation of the straightedge. The calibration strip shall be
4 a 100-ft section of pavement that is reasonably level and smooth. Submit each day's
5 calibration graphs with that day's test section graphs to the Engineer. Calibrate the
6 straightedge in accordance with the current NCDOT procedure titled *North Carolina*
7 *Hearne Straightedge - Calibration and Determination of Cumulative Straightedge Index*.
8 Copies of this procedure may be obtained from the Department's Pavement Section in the
9 Construction Unit.

10 Plot the straightedge graph at a horizontal scale of approximately 25 ft/in with the vertical
11 scale plotted at a true scale. Record station numbers and references (bridges, approach
12 slabs, culverts, etc.) on the graphs. Distances between references/stations shall not
13 exceed 100 ft. Have the operator record the Date, Project No., Lane Location, Wheel
14 Path Location, Type Mix and Operator's Name on the graph.

15 Upon completion of each day's testing, evaluate the graph, calculate the Cumulative
16 Straightedge Index (CSI) and determine which lots, if any, require corrective action.
17 Document the evaluation of each lot on a QA/QC-7 form. Submit the graphs along with
18 the completed QA/QC-7 forms to the Engineer, within 24 hours after profiles are
19 completed, for verification of the results. The Engineer will furnish results of their
20 acceptance evaluation to the Contractor within 48 hours of receiving the graphs. In the
21 event of discrepancies, the Engineer's evaluation of the graphs will prevail for acceptance
22 purposes. The Engineer will retain all graphs and forms.

23 Use blanking bands of 0.2", 0.3" and 0.4" to evaluate the graph for acceptance. The
24 0.2" and 0.3" blanking bands are used to determine the Straightedge Index (SEI), which
25 is a number that indicates the deviations that exceed each of the 0.2" and 0.3" bands
26 within a 100 ft test section. The Cumulative Straightedge Index (CSI) is a number
27 representing the total of the SEIs for one lot, which consist of not more than
28 25 consecutive test sections. In addition, the 0.4" blanking band is used to further
29 evaluate deviations on an individual basis. The CSI will be determined by the Engineer
30 in accordance with the current procedure titled *North Carolina Hearne Straightedge -*
31 *Calibration and Determination of Cumulative Straightedge Index*.

32 The pavement will be accepted for surface smoothness on a lot by lot basis. A test
33 section represents pavement one travel lane wide not more than 100 ft in length. A lot
34 will consist of 25 consecutive test sections, except that separate lots will be established
35 for each travel lane, unless otherwise approved by the Engineer. In addition, full width
36 acceleration or deceleration lanes, ramps, turn lanes and collector lanes will be evaluated
37 as separate lots. For any lot that is less than 2,500 ft in length, the applicable pay
38 adjustment incentive will be prorated on the basis of the actual lot length. For any lot
39 which is less than 2,500 ft in length, the applicable pay adjustment disincentive will be
40 the full amount for a lot, regardless of the lot length.

41 If during the evaluation of the graphs, 5 lots require corrective action, then proceed on
42 limited production for unsatisfactory laydown in accordance with Article 610-12.
43 Proceeding on limited production is based upon the Contractor's initial evaluation of the
44 straightedge test results and shall begin immediately upon obtaining those results.
45 Additionally, the Engineer may direct the Contractor to proceed on limited production in
46 accordance with Article 610-12 due to unsatisfactory laydown or workmanship.

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Limited production for unsatisfactory laydown is defined as being restricted to the production, placement, compaction and final surface testing of a sufficient quantity of mix necessary to construct only 2,500 ft of pavement at the laydown width. Once this lot is complete, the final surface testing graphs will be evaluated jointly by the Contractor and the Engineer. Remain on limited production until such time as acceptable laydown results are obtained or until 3 consecutive 2,500 ft sections have been attempted without achieving acceptable laydown results. The Engineer will determine if normal production may resume based upon the CSI for the limited production lot and any adjustments to the equipment, placement methods, and/or personnel performing the work. Once on limited production, the Engineer may require the Contractor to evaluate the smoothness of the previous asphalt layer and take appropriate action to reduce and/or eliminate corrective measures on the final surface course. Additionally, the Contractor may be required to demonstrate acceptable laydown techniques off the project limits before proceeding on the project.

If the Contractor fails to achieve satisfactory laydown results after 3 consecutive 2,500 ft sections have been attempted, cease production of that mix type until such time as the cause of the unsatisfactory laydown results can be determined.

As an exception, the Engineer may grant approval to produce a different mix design of the same mix type if the cause is related to mix problem(s) rather than laydown procedures. If production of a new mix design is allowed, proceed under the limited production procedures detailed above.

After initially proceeding under limited production, the Contractor shall immediately notify the Engineer if any additional lot on the project requires corrective action. The Engineer will determine if limited production procedures are warranted for continued production.

If the Contractor does not operate by the limited production procedures as specified above, the 5 lots, which require corrective action, will be considered unacceptable and may be subject to removal and replacement. Mix placed under the limited production procedures for unsatisfactory laydown will be evaluated for acceptance in accordance with Article 105-3.

The pay adjustment schedule for the Cumulative Straightedge Index (CSI) test results per lot is in Table 610-8.

CSI^A	Acceptance Category	Corrective Action	Pay Adjustment Before Corrective	Pay Adjustment After Corrective Action
0-0	Acceptable	None	\$300 Incentive	None
1-0 or 2-0	Acceptable	None	\$100 Incentive	None
3-0 or 4-0	Acceptable	None	No Adjustment	No Adjustment
1-1, 2-1, 5-0 or 6-0	Acceptable	Allowed	\$300 Disincentive	\$300 Disincentive
3-1, 4-1, 5-1 or 6-1	Acceptable	Allowed	\$600 Disincentive	\$600 Disincentive
Any other Number	Unacceptable	Required	Per CSI after Correction(s) (not to exceed 100% Pay)	

A. Either Before or After Corrective Actions

1 Correct any deviation that exceeds a 0.4" blanking band such that the deviation is reduced
2 to 0.3" or less.

3 Corrective actions shall be performed at the Contractor's expense and shall be presented
4 for evaluation and approval by the Engineer prior to proceeding. Any corrective action
5 performed shall not reduce the integrity or durability of the pavement that is to remain in
6 place. Corrective action for deviation repair may consist of overlaying, removing and
7 replacing, indirect heating and rerolling. Scraping of the pavement with any blade type
8 device will not be allowed as a corrective action. Provide overlays of the same type mix,
9 full roadway width, and to the length and depth established by the Engineer. Tapering of
10 the longitudinal edges of the overlay will not be allowed.

11 Corrective actions will not be allowed for lots having a CSI of 4-0 or better. If the CSI
12 indicates Allowed corrective action, the Contractor may elect to take necessary measures
13 to reduce the CSI instead of accepting the disincentive. Take corrective actions as
14 specified if the CSI indicates Required corrective action. The CSI after corrective action
15 shall meet or exceed Acceptable requirements.

16 Where corrective action is allowed or required, the test section(s) requiring corrective
17 action will be retested, unless the Engineer directs the retesting of the of the entire lot.
18 No disincentive will apply after corrective action if the CSI is 4-0 or better. If the
19 retested lot after corrective action has a CSI indicating a disincentive, the appropriate
20 disincentive will be applied.

21 Test sections and/or lots that are initially tested by the Contractor that indicate excessive
22 deviations such that either a disincentive or corrective action is necessary, may be
23 re-rolled with asphalt rollers while the mix is still warm and in a workable condition, to
24 possibly correct the problem. In this instance, reevaluation of the test section(s) shall be
25 completed within 24 hours of pavement placement and these test results will serve as the
26 initial test results.

27 Incentive pay adjustments will be based only on the initially measured CSI, as
28 determined by the Engineer, before any corrective work. Where corrective actions have
29 been taken, payment will be based on the CSI determined after correction, not to exceed
30 100% payment.

31 Areas excluded from testing by the N.C. Hearne Straightedge will be tested by using
32 a non-mobile 10-ft straightedge. Assure that the variation of the surface from the
33 testing edge of the straightedge between any 2 contact points with the surface is not more
34 than 1/8". Correct deviations exceeding the allowable tolerance in accordance with the
35 corrective actions specified above, unless the Engineer permits other corrective actions.

36 Furnish the North Carolina Hearne Straightedge(s) necessary to perform this work.
37 Maintain responsibility for all costs relating to the procurement, handling, and
38 maintenance of these devices. The Department has entered into a license agreement with
39 a manufacturer to fabricate, sell and distribute the N.C. Hearne Straightedge. The
40 Department's Pavement Construction Section may be contacted for the name of the
41 current manufacturer and the approximate price of the straightedge.

42 **610-14 DENSITY ACCEPTANCE**

43 The Department will evaluate the asphalt pavement for density acceptance after the asphalt
44 mix has been placed and compacted using the Contractor's QC test results, the Department's
45 QA test results (including verification samples) and by observation of the Contractor's density
46 QC process conducted in accordance with Section 609. Minimum density requirements for
47 all mixes will be as specified in Table 610-6. Density acceptance will be as provided herein.
48 Core sample densities will be determined by use of the average maximum specific
49 gravity (G_{mm}), until a moving average of the last 4 maximum specific gravities is established.
50 Once a moving average of the last 4 maximum specific gravities is established, the last
51 G_{mm} moving average in effect at the end of the same day's production will then be used to
52 determine density acceptance.

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The pavement will be accepted for density on a lot by lot basis. A lot will consist of one day's production of a given JMF on a contract. As an exception, separate lots will be established when one of the following occurs:

(A) Portions of pavement are placed in both New and Other construction categories as defined below. A lot will be established for the portion of the pavement in the New construction category and a separate lot for the portion of pavement in the Other construction category.

(B) Pavement is placed on multiple resurfacing maps. Unless otherwise approved before paving, a lot will be established for each individual resurfacing map or portion thereof.

(C) Pavement is placed by multiple paving crews. A lot will be established for the pavement placed by each paving crew.

(D) Pavement is placed in different layers. A lot will be established for each layer.

(E) Control strips are placed during limited production.

The Engineer will determine the final category and quantity of each lot for acceptance purposes. The New construction category will be defined as pavements of uniform thickness, exclusive of irregular areas, meeting all 3 of the following criteria:

(1) Pavement placed on a new aggregate or soil base compacted to the specified density or pavement placed on a new asphalt mix layer (excluding wedging and leveling);

(2) Pavement that is within a designated travel lane of the final traffic pattern; and

(3) Pavement that is 4.0 ft or wider.

As an exception, when the first layer of mix is a surface course and is being placed directly on an unprimed aggregate or soil base, the layer will be included in the Other construction category.

The Other construction category will include all pavements except as described above.

A failing lot for density acceptance purposes is defined as a lot for which the average of all test sections, and portions thereof, fails to meet the minimum specification requirement. If additional density sampling and testing, beyond the minimum requirement, is performed and additional test sections are thereby created, then all test results shall be included in the lot average. In addition, any lot or portion of a lot that is obviously unacceptable will be rejected for use in the work.

If the Engineer determines that a given lot of mix that falls in the New category does not meet the minimum specification requirements but the work is reasonably acceptable, the lot will be accepted at a reduced pay factor in accordance with the following formula. The reduced pay factor will apply only to the mix unit price.

$$\text{Reduced Pay Factor} = 100 + \left[\left(\frac{\text{Actual Density} - \text{Specified Density}}{2} \right) \times 30 \right]$$

Where:

Actual Density = the lot average density, not to exceed 2.0% of the specified density

Specified Density = the density in Table 610-6 or as specified in the contract

All failing lots in the Other category will be evaluated for acceptance in accordance with Article 105-3.

1 Any density lot not meeting minimum density requirements detailed in Table 610-6 will be
 2 evaluated for acceptance in accordance with Article 105-3. If the lot is determined not to be
 3 acceptable, the mix will be removed and replaced with mix meeting and compacted to the
 4 requirement of these *Standard Specifications*.

5 **610-15 MAINTENANCE**

6 Maintain the plant mix pavement in an acceptable condition until final acceptance of the
 7 project. Immediately repair any defects or damage that may occur. Perform maintenance to
 8 damaged or defective pavement and repeat as often as may be necessary to keep the base or
 9 pavement in an acceptable condition.

10 **610-16 MEASUREMENT AND PAYMENT**

11 *Hot Mix Asphalt Pavement* will be paid at the contract unit price per ton that will be the actual
 12 number of tons of each type of hot mix asphalt pavement incorporated into the completed and
 13 accepted work in accordance with Article 106-7.

14 No direct payment will be made for providing and using the materials transfer vehicle or any
 15 associated equipment, as the cost of providing same will be included in the contract unit bid
 16 price per ton for the mix type to be placed.

17 Any reduction in pay due to failing density will be in addition to any reduction in pay due to
 18 failing mix property test results on the same mix.

19 A high frequency of asphalt plant mix or density deficiencies may result in future deficient
 20 asphalt being excluded from acceptance at an adjusted contract unit price in accordance with
 21 Article 105-3. This acceptance process will apply to all asphalt produced or placed and will
 22 continue until the Engineer determines a history of quality asphalt production and placement
 23 is reestablished.

24 Furnishing asphalt binder will be paid as provided in Article 620-4 for *Asphalt Binder for*
 25 *Plant Mix* for each grade required.

26 Provide the work and materials required in the correction of defective work or sand seal base
 27 course as required at no cost to the Department. If the Engineer has such work performed
 28 with Department forces and equipment, the cost of such work performed by Department
 29 forces will be deducted from monies due or to become due to the Contractor.

30 No direct payment will be made for final surface testing covered by this section. Payment at
 31 the contract unit prices for the various items covered by those sections of the *Standard*
 32 *Specifications* directly applicable to the work constructed will be full compensation for all
 33 work covered by Article 660-11 including, but not limited to, performing testing in
 34 accordance with this Specification, any corrective work required as a result of this testing and
 35 any additional traffic control as may be necessary.

36 Payment will be made under:

Pay Item	Pay Unit
Asphalt Concrete Base Course, Type B25.0B	Ton
Asphalt Concrete Base Course, Type B25.0C	Ton
Asphalt Concrete Intermediate Course, Type I19.0B	Ton
Asphalt Concrete Intermediate Course, Type I19.0C	Ton
Asphalt Concrete Intermediate Course, Type I19.0D	Ton
Asphalt Concrete Surface Course, Type SF9.5A	Ton
Asphalt Concrete Surface Course, Type S9.5B	Ton
Asphalt Concrete Surface Course, Type S9.5C	Ton
Asphalt Concrete Surface Course, Type S9.5D	Ton
Asphalt Concrete Surface Course, Type S12.5C	Ton
Asphalt Concrete Surface Course, Type S12.5D	Ton

Section 620

**SECTION 620
ASPHALT BINDER FOR PLANT MIX**

620-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing of asphalt binder, with anti-strip additive when required, at an asphalt plant and incorporating the asphalt binder and anti-strip additive into the asphalt plant mix.

620-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-strip Additives	1012-1(G)
Asphalt Binder, All Grades	1020-2
Silicone	1012-1(H)

The asphalt binder for the mixture will be accepted at the source subject to Article 1020-1.

Use a brand of silicone from the NCDOT Approved Products List. Submit a sample and manufacturer's data to the Engineer for approval before use, if proposing to use a brand not on the NCDOT Approved Products List.

620-3 GENERAL REQUIREMENTS

The requirements of Section 610 that pertain to handling of asphalt binder will be applicable to the work covered by this section.

Add silicone to all asphalt binder used in surface courses and open-graded asphalt friction course, unless otherwise directed. The amount of silicone added will range from one ounce per 2,000 gallons of asphalt binder to one ounce per 2,500 gallons. Add silicone to the asphalt binder at the plant site unless added at the source and it is so noted on the delivery ticket.

Do not heat the asphalt binder to a temperature in excess of the supplier's recommendation while stored or when being used in production of mix at the asphalt plant.

Introduce the actual quantity of asphalt binder at the established percentage shown on the applicable JMF into the mix by the plant weighing or metering system. No working tolerance for asphalt binder percentage will be allowed during production.

When required, incorporate an anti-strip additive. It may be either chemical additive mixed with the asphalt binder or hydrated lime added to the aggregate or a combination of both. Furnish the brand name of the type (lime or chemical), supplier and shipping point of anti-strip additive. Note on the asphalt binder delivery ticket the rate (or quantity), brand of chemical additive when added at the supplier's terminal. Introduce and mix chemical anti-strip additive into the asphalt binder at either the supplier's terminal or at the asphalt plant site at the dosage required by the JMF. Use in-line blending equipment at either location. When added at the asphalt plant, use equipment that meets Subarticle 610-5(B). When added at the supplier's terminal, use equipment that in-line blends with a constant flow of the additive for a minimum of 80% of the asphalt binder loading time. When hydrated lime is used, use equipment to introduce the lime that meets Subarticle 610-5(B). Thoroughly mix chemical anti-strip additive and asphalt binder together before incorporating into the asphalt plant mix.

620-4 MEASUREMENT AND PAYMENT

Asphalt Binder for Plant Mix and *Polymer Modified Asphalt Binder for Plant Mix* will be measured and paid as the theoretical number of tons required by the applicable JMF based on the actual number of tons of plant mix completed and accepted on the job.

Such price and payment will be full compensation for all work covered by this section.

1 There will be no direct payment for anti-strip additive. Payment at the contract unit prices for
2 the various asphalt plant mix items will be full compensation for the work.

3 Adjustments will be made to the payments due the Contractor for each grade of asphalt binder
4 when it has been determined that the monthly average terminal F.O.B. Selling Price of asphalt
5 binder, Grade PG 64-22, has fluctuated from the Base Price Index for Asphalt Binder
6 included in the contract. The methods for calculating a base price index, for calculating the
7 monthly average terminal F.O.B. selling price and for determining the terminals used are in
8 accordance with procedures on file with the Construction Unit.

9 When it is determined that the monthly selling price of asphalt binder on the first business day
10 of the calendar month during which the last day of the partial payment period occurs varies
11 either upward or downward from the base price index, the contract unit price for asphalt
12 binder for plant mix will be adjusted. The adjusted contract unit price will be determined by
13 adding the difference between the selling price and the base price index to the contract unit
14 bid price for asphalt binder.

15 The adjusted contract unit price will then be applied to the theoretical quantity of asphalt
16 binder authorized for use in the plant mix placed during the partial payment period involved,
17 except that where recycled plant mix is used, the adjusted unit price will be applied only to
18 the theoretical number of tons of additional asphalt binder materials required by the JMF.

19 Adjusted contract unit prices for all grades of asphalt binder, including additional asphalt
20 binder materials in recycled mixtures, will be based on the average selling price and base
21 price index for asphalt binder, Grade PG 64-22, regardless of the actual grade required by
22 the JMF.

23 In determining the adjusted contract unit price for any material specified in this section the
24 following formula will be used:

$$\mathbf{A} = \mathbf{B} + (\mathbf{D} - \mathbf{C})$$

Where:

A = Adjusted Contract Unit Price

B = Contract Unit Price

C = Base Price Index

D = Monthly Average Terminal F.O.B. Selling Price

25 In the event the Department is unable to secure an F.O.B. selling price from at least
26 4 terminals in a given month, payment will be at the contract unit price for each ton of asphalt
27 binder used in the work during that month.

28 Payment will be made under:

Pay Item	Pay Unit
Asphalt Binder for Plant Mix	Ton
Polymer Modified Asphalt Binder for Plant Mix	Ton

Section 650

**SECTION 650
OPEN-GRADED ASPHALT FRICTION COURSE,
TYPES FC-1, FC-1 MODIFIED AND FC-2 MODIFIED**

650-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, construction of a plant mixed open-graded asphalt friction course (OGAFC) properly laid upon a prepared surface in accordance with these Specifications and in conformity with the lines, grades, thickness and typical sections shown on the plans; producing, weighing, transporting, placing and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive, fiber stabilizing additive and all other materials for the plant mix; furnishing and applying tack coat as specified; providing QC as specified in Section 609 as modified for OGAFC; surface testing of the completed pavement; furnishing scales; making any repairs or corrections to the friction course that may become necessary and maintaining the friction course until final acceptance of the project.

650-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-strip Additives	1012-1(G)
Asphalt Binder, Grade PG 64-22, PG 76-22	1020-2
Coarse Aggregate	1012-1(B)
Fiber Stabilizing Additives	1012-1(I)
Fine Aggregate	1012-1(C)
Mineral Filler	1012-1(D)
Reclaimed Asphalt Shingles (RAS)	1012-1(F)

650-3 COMPOSITION OF MIXTURE (MIX DESIGN AND JOB MIX FORMULA)

(A) General

Design the open-graded asphalt friction course using a mixture of coarse and fine aggregate, asphalt binder, mineral filler, fiber stabilizing additive and other additives as required to produce a mix meeting Table 650-1.

Submit in writing a mix design and proposed JMF targets for each required mix type and combination of aggregates to the Engineer for review and approval at least 20 days before start of asphalt mix production. The mix design shall be prepared by a mix design technician approved by the Department in an approved mix design laboratory. Perform the mix design in accordance with Article 610-3 and the Department's mix design procedures. Copies of these procedures can be obtained through the Materials and Tests Unit. Submit the mix design and proposed JMF targets on forms and in a format approved by the Department.

The mix design and JMF target values will be established within the mix design criteria specified in Table 650-1 for the particular type of mixture to be produced. The formula for each mixture will indicate the blend percentage of each aggregate fraction to be used, a single percentage of combined aggregate passing each required sieve, the percentage and grade of asphalt binder (by weight of total mixture) to be incorporated into the mixture, the percentage of anti-strip additive to be added to the asphalt binder, the percentage of fiber stabilizing additive (by weight of total mix) and the temperature at which the mixture is to be discharged from the plant.

Have on hand at the asphalt plant the approved mix design and JMF issued by the Department, before beginning the work.

1 The JMF for each mixture shall remain in effect until modified in writing, provided the
 2 results of tests performed on material currently being produced conform with
 3 specification requirements.

4 If a change in sources of aggregate materials needs to be made, a new mix design and
 5 JMF will be required before the new mixture is produced.

6 When unsatisfactory results or other conditions make it necessary, the Engineer may
 7 establish a new JMF.

8 **(B) Mix Design Criteria**

9 Design open-graded asphalt friction course (OGAFC) mixtures conforming to the
 10 gradation requirements and other mix design criteria in Table 650-1 for the mix type
 11 specified.

12 Use the asphalt binder grade shown in Table 650-1 for the mix type specified. RAS may
 13 be used in accordance with Subarticle 610-3(A).

14 Use an anti-strip additive in all OGAFC mixes. It may be hydrated lime or a chemical
 15 additive or both. Add chemical anti-strip additive at a rate of 0.5% by weight of asphalt
 16 binder. Add hydrated lime at a rate of 1.0% by weight of dry aggregate. Use
 17 an approved source and grade.

18 If needed to prevent asphalt draindown, incorporate a fiber stabilizing additive into all
 19 OGAFC types. Add the fiber at a dosage rate by weight of the total mix as approved.

20 When requested, submit to the Materials and Tests Unit in Raleigh, samples of mix
 21 components. Submit sample sizes as noted below or as requested. Provide the samples
 22 at least 20 days before the anticipated beginning placement of OGAFC mixture.

23 250 lb of each coarse aggregate
 24 150 lb of each fine aggregate
 25 1 gal. of mineral filler and/or baghouse fines
 26 1 gal. of hydrated lime OR 1 pint of chemical anti-strip additive
 27 4 lb of fiber stabilizing additive (if used)

28 Aggregate samples when combined according to the Contractor's proposed aggregate
 29 blend percentages shall be within the gradation range defined by the target values of
 30 Table 650-1 for each sieve or the samples will not be representative.

31 The mixing temperature at the asphalt plant will be established on the JMF.

32 Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

Grading Requirements	Total Percent Passing		
<i>Sieve Size (mm)</i>	<i>Type FC-1</i>	<i>Type FC-1 Modified</i>	<i>Type FC-2 Modified</i>
19.0	-	-	100
12.5	100	100	85 - 100
9.50	75 - 100	75 - 100	55 - 75
4.75	25 - 45	25 - 45	15 - 25
2.36	5 - 15	5 - 15	5 - 10
0.075	1.0 - 3.0	1.0 - 3.0	2.0 - 4.0

Section 650

**TABLE 650-2
OGAFC MIX DESIGN CRITERIA**

Property	Design Parameters		
Asphalt Binder Grade	PG 64-22	PG 76-22	PG 76-22
Asphalt Binder, % Range	5.0 - 8.0	5.0 - 8.0	5.0 - 8.0
Mixing Temperature Range Established by Engineer	200 - 275°F	300 - 350°F	300 - 350°F
Draindown,%, AASHTO T 305	0.3 max.	0.3 max.	0.3 max.

1 650-4 PLANT EQUIPMENT

2 Use plant equipment in accordance with Article 610-5 and the requirements herein.

3 When fiber stabilizing additives are used as an ingredient of the mixture, use a separate feed
4 system capable of accurately proportioning the required quantity into the mixture and in such
5 a manner that uniform distribution will be obtained. Interlock the proportioning device with
6 the aggregate feed or weigh system so as to maintain the correct proportions for all rates of
7 production and batch sizes. Accurately control the proportion of fibers to within $\pm 10\%$ of the
8 amount required. Provide flow indicators or sensing devices for the fiber system that are
9 interlocked with plant controls such that mixture production will be interrupted if introduction
10 of the fiber fails.

11 When a batch type plant is used, add the fiber to the aggregate in the weigh hopper or as
12 approved. Increase the batch dry mixing time by 8 to 12 seconds, or as directed, to assure the
13 fibers are uniformly distributed before the injection of asphalt binder into the mixer.

14 When a continuous mix or dryer-drum type plant is used, add the fiber to the aggregate and
15 uniformly disperse at the point of injection of asphalt binder. Add the fiber in such a manner
16 that it will not become entrained in the exhaust system of the drier or plant.

17 650-5 CONSTRUCTION METHODS

18 Produce, transport to the site and place the OGAFC in accordance with Section 610, except as
19 otherwise provided below.

20 Do not place OGAFC between October 31 and April 1 of the next year, unless otherwise
21 approved. Place friction course, Type FC-1 mixes, only when the road surface temperature is
22 50°F or higher and the air temperature measured in the shade away from artificial heat is 50°F
23 or higher. The minimum air and road surface temperature for placing Type FC-1 Modified
24 and FC-2 Modified mixes will be 60°F.

25 Before starting production of the mix, stockpile all aggregates for a sufficient period of time
26 to facilitate the drainage of free moisture.

27 Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

28 Clean the existing surface in an acceptable manner before placement of any asphalt material.

29 Remove all existing raised pavement markers as directed and repair any damaged areas
30 caused by the removal. Use an approved dense graded mixture of similar type material for the
31 repair.

32 Apply tack coat in accordance with Section 605 and the following

33 **(A)** Use Asphalt Binder, Grade PG 64-22 tack coat material or as approved.

34 **(B)** Uniformly apply the tack coat material at a rate of application 0.06 to 0.08 gal/sy, as
35 directed.

36 Spread and finish the friction course as specified in Article 610-8. Roll the friction
37 course as specified in Article 610-9.

- 1 Perform this work in accordance with and using equipment meeting Section 9.5 of the
2 *HMA/QMS Manual*.
- 3 Use a Material Transfer Vehicle (MTV) when placing all types of OGAFC. Use a MTV
4 meeting Section 9.5(E) of the *HMA/QMS Manual*.
- 5 Remove and replace any part of the finished friction course that shows non-uniform
6 distribution of asphalt binder, aggregate or fiber at no additional cost to the Department.
- 7 Coordinate plant production, transportation and paving operations such that uniform
8 continuity of operation is maintained. If spreading operations are interrupted, the Engineer
9 may require that a transverse joint be constructed any time the mixture immediately behind
10 the paver screed cools to less than 250°F.
- 11 When OGAFC, Type FC-2 Modified mixture is specified, use OGAFC, Type FC-1 Modified
12 on entrance and exit ramps, gore areas and at end of project construction joints. Adjust the
13 thickness of placement as specified below.
- 14 For end of project joints, provide a transition area consisting of one load of mixture per lane,
15 or as directed. Taper the mixture in thickness from 3/8" at the end of the project to the typical
16 thickness (approximately 3/4") within the maximum distance of spread for one load of
17 mixture. For ramps and gore areas, taper the mixture in thickness from that at the edge of the
18 mainline, approximately 3/4" to 3/8" at the point of the ramp transverse joint. Construct the
19 ramp transverse joint at a point specified by the plans or as directed.

20 **650-6 QUALITY MANAGEMENT SYSTEM**

- 21 Produce the OGAFC in accordance with Section 609.

22 **650-7 MEASUREMENT AND PAYMENT**

- 23 *Open-Graded Asphalt Friction Course, Type FC-1, Type FC-1 Modified or Type FC-2*
24 *Modified* will be measured and paid as the actual number of tons of friction course
25 incorporated into the completed and accepted work. The friction course will be measured by
26 being weighed in trucks on certified platform scales or other certified weighing devices.
- 27 Furnishing asphalt binder for the mix will be paid as provided in Article 620-4 for *Asphalt*
28 *Binder for Plant Mix*. Adjustments in contract unit price due to asphalt binder price
29 fluctuation will be made in accordance with Section 620.
- 30 No direct payment will be made for providing and using the materials transfer vehicle or any
31 associated equipment, as the cost of providing same shall be included in the contract unit bid
32 price per ton for the mix type to be placed.
- 33 Payment will be made under:

Pay Item	Pay Unit
Open-Graded Asphalt Friction Course, Type FC-1	Ton
Open-Graded Asphalt Friction Course, Type FC-1 Modified	Ton
Open-Graded Asphalt Friction Course, Type FC-2 Modified	Ton

Section 652

**SECTION 652
PERMEABLE ASPHALT DRAINAGE COURSE,
TYPES P-78M AND P-57**

652-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, the construction of a plant mixed permeable asphalt drainage course (PADC) properly laid upon a prepared surface in accordance with these Specifications and in conformity with the lines, grades, thickness and typical sections shown on the plans; producing, weighing, transporting, placing and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; furnishing scales; providing QC as specified in Section 609 as modified for PADC; making any repairs or corrections to the friction course that may become necessary; and maintaining the friction course until final acceptance of the project.

652-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-strip Additives	1012-1(G)
Asphalt Binder	1020-2
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)

The coarse aggregate shall meet Article 1012-1 except that that portion of the coarse aggregate retained on the No. 4 sieve shall contain at least 60% by weight of crushed pieces having 2 or more mechanically induced fractured faces.

652-3 COMPOSITION OF MIXTURE

(A) General

Formulate the PADC from a mixture of crushed aggregate, asphalt binder, anti-strip additive and other additives as required to produce a mix meeting Table 652-1.

Submit in writing a mix design (M&T 601 only) and proposed JMF targets for each required mix type and combination of aggregates to the Engineer for review and approval at least 10 days before start of asphalt mix production. The JMF will be established in accordance with Article 610-3. Establish the asphalt binder content at the midpoint of the range specified in Table 652-1 or as approved. Submit the mix design and proposed JMF targets on forms and in a format approved by the Department.

The formula for each mixture will indicate the blend percentage of each aggregate fraction to be used, a single percentage of combined aggregate passing each required sieve, the percentage and grade of asphalt binder (by weight of total mixture) to be incorporated into the mixture, the percentage of anti-strip additive to be added to the asphalt binder and the temperature at that the mixture is to be discharged from the plant.

Have on hand at the asphalt plant the approved mix design and JMF issued by the Department, before beginning the work.

The JMF for each mixture will remain in effect until modified in writing, provided the results of QMS tests performed on material currently being produced conform with specification requirements.

If a change in sources of aggregate materials needs to be made, a new mix design and JMF will be required before the new mixture is produced.

When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new JMF.

(B) Mix Design

Design PADC mixtures conforming to the gradation requirements and other mix design criteria in Table 652-1 for the mix type specified.

Use the asphalt binder grade shown in Table 652-1 for the mix type specified or as approved.

Use an anti-strip additive in all PADC mixes. It may be hydrated lime or a chemical additive or both. Add chemical anti-strip additive at a rate of 0.5% by weight of asphalt binder. Add hydrated lime at a rate of 1.0% by weight of dry aggregate. Use an approved source and grade.

When requested, submit samples of mix components to the Materials & Tests Unit. Submit sample sizes as noted below or as requested. Provide the samples at least 20 days before the anticipated beginning placement of PADC mixture.

250 lb of each coarse aggregate

150 lb fine aggregate

2 gal. of asphalt binder

1 pint of anti-strip additive

Aggregate samples when combined according to the Contractor's proposed aggregate blend percentages shall be within the gradation range defined by the target values of Table 652-1 for each sieve or the samples will not be representative.

The mixing temperature at the asphalt plant will be established on the JMF.

**TABLE 652-1
PERMEABLE ASPHALT DRAINAGE COURSE
GRADATION AND MIX DESIGN CRITERIA**

Sieve Size (mm)	Total Percent Passing	
	Type P-78M	Type P-57
37.5	-	100
25.0	-	95 - 100
19.0	100	-
12.5	95 - 100	25 - 60
9.50	75 - 100	-
4.75	20 - 45	10 - 20
2.36	3 - 15	5 - 10
0.075	1.0 - 3.0	1.0 - 3.0
Asphalt Binder Content, %	2.5 - 3.5	2.0 - 3.0
Mixing Temperature at Plant (Established by the Engineer)	240 - 270°F	260 - 290°F

652-4 CONSTRUCTION METHODS

Produce, transport to the site and place the asphalt plant mix in accordance with Section 610, except as otherwise provided herein.

Incorporate the asphalt binder into the asphalt plant mix in accordance with Section 620. Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

A prime coat or tack coat will not be required.

When the PADC is placed in trench sections, the rolling equipment and rolling sequences required by Article 610-9 will not apply. Compact the PADC to a degree acceptable to the Engineer.

Section 654

1 Following placement of the PADC mixture to the appropriate line, grade and thickness, begin
2 rolling when the mat has cooled sufficiently to support the weight of an 8 to 12 ton steel-
3 wheel tandem roller. Mat temperature at the time of initial rolling shall be approximately
4 175°F to 225°F. The number of roller passes will be 2 or 3, unless otherwise directed.
5 Consolidate the drainage layer sufficiently with rolling so as to support the weight of
6 equipment that will place the next layer of pavement. Do not compact the drainage layer to
7 the extent that it is not free draining or that the aggregate is crushed.

8 No construction traffic will be allowed to travel on any PADC layer. Only equipment
9 necessary to place the next layer of pavement will be allowed on the drainage layer.

10 Do not place PADC that will not be covered with the next layer of pavement during the same
11 calendar year or within 15 days of placement if the PADC is placed in January or February.

12 **652-5 QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS**

13 Produce the PADC in accordance with the Section 609.

14 **652-6 MEASUREMENT AND PAYMENT**

15 *Permeable Asphalt Drainage Course, Type ____* will be paid as the actual number of tons of
16 drainage course incorporated into the completed and accepted work. The drainage course will
17 be measured by being weighed in trucks on certified platform scales or other certified
18 weighing devices.

19 *Asphalt Binder for Plant Mix* will be paid in accordance with Article 620-4.

20 Payment will be made under:

Pay Item	Pay Unit
Permeable Asphalt Drainage Course, Type P-78M	Ton
Permeable Asphalt Drainage Course, Type P-57	Ton

21 **SECTION 654**
22 **ASPHALT PLANT MIX, PAVEMENT REPAIR**

23 **654-1 DESCRIPTION**

24 Perform the work covered by this section including, but not limited to, repairing of existing
25 pavement with asphalt plant mix in order to provide a safe, passable and convenient condition
26 for traffic, or to replace pavement removed in order to remove or to place pipe lines.

27 Perform the work by cutting the existing pavement to a neat vertical joint and uniform line;
28 removing and disposing of pavement, base and subgrade material as approved or directed;
29 coating the area to be repaired with a tack coat; furnishing, placing and compacting asphalt
30 plant mix; and replacing of the removed material with asphalt plant mix.

31 Make the repairs in accordance with the plans, or as approved or directed.

32 **654-2 MATERIALS**

33 Where a pavement repair detail is not shown in the plans, use an approved asphalt plant mix.

34 Where a pavement repair detail is shown in the plans, the type of plant mix shall be in
35 accordance with the pavement repair detail except where the Specifications permit the
36 substitution of another type of plant mix or where approved.

37 In areas where the existing pavement is not to be resurfaced, the Contractor will not be
38 allowed to substitute a different type of surface course from that shown on the pavement
39 repair detail.

Section 660

1 Heat and apply the sealant material according to the manufacturer’s recommendations. Use
2 a portable melting kettle for heating the material that is equipped with indirect heating
3 (air-jacketed flow) and is capable of constantly agitating the joint sealer to maintain a uniform
4 temperature. Equip the kettle with either mechanically operated paddles and/or a continuous
5 circulating pump to maintain agitation. Use heating equipment capable of controlling the
6 sealant material temperature within the manufacturer’s recommended temperature range and
7 that is thermostatically-control calibrated between 200°F to 600°F. Locate a thermometer on
8 the kettle so the Engineer can safely check the temperature of the sealant material.
9 Overheating of the sealant material will not be permitted.

10 Apply sealant in the prepared cracks and joints within the manufacturer’s recommended
11 temperature range, using a pressure screed shoe to completely fill the crack or joint, leaving
12 a sealed 2" overband. Excessive overbanding or waste of sealant materials will not be
13 tolerated. Immediately squeegee the crack seal material to minimize the height of the
14 overband. All sealed cracks and joints shall have a minimum of 1/8" depth of sealant
15 installed.

16 Do not apply the hot applied joint sealer when the surface temperature of the pavement is
17 below 32°F. Follow manufacturer’s recommendations.

18 After the crack or joint has been sealed, promptly remove any surplus sealer on the pavement.
19 Do not permit traffic over the sealed cracks and joints without approval by the Engineer.
20 When approved by the Engineer, place sand or other approved material over the crack or joint
21 to prevent tracking.

22 **657-4 MEASUREMENT AND PAYMENT**

23 Sealing existing pavement cracks and joints will be measured and paid as the actual number
24 of pounds of material that has satisfactorily been used to seal pavement cracks and joints in
25 the designated highway. Any material spilled, used in excessive overbanding, wasted,
26 misapplied or unsatisfactorily used in any way will be deducted in determining quantities for
27 payment. The Engineer will determine the quantity, if any, to be deducted. The Engineer's
28 decision on the quantity to be deducted will be final and binding.

29 Payment will be made under:

Pay Item	Pay Unit
Sealing Existing Pavement Cracks and Joints	Pound

30 **SECTION 660**
31 **ASPHALT SURFACE TREATMENT**

32 **660-1 DESCRIPTION**

33 Perform the work covered by this section including, but not limited to, furnishing, hauling,
34 spreading and rolling the asphalt material and aggregate consisting of one or more
35 applications of liquid asphalt material and one or more applications of aggregate cover coat
36 material on a prepared surface; furnishing and spreading blotting sand; and maintaining and
37 repairing the asphalt surface treatment.

38 **660-2 MATERIALS**

39 Refer to Division 10.

40 Use one of the following grades of asphalt:

Item	Section
Aggregates for Asphalt Surface Treatment	1012-2
Blotting Sand	1012-3
Emulsified Asphalt, Grade CRS-2	1020-3
Emulsified Asphalt, Grade CRS-2L	1020-3

Item	Section
Emulsified Asphalt, Grade CRS-2P	1020-3
Emulsified Asphalt, Grade CSS-1H	1020-3
Fine Aggregate	1014
Mineral Filler	1012-1(D)
Water	1024-4

1 Before any asphalt surface treatment is placed, obtain from the asphalt supplier and furnish to
 2 the Engineer a certification of compatibility of the asphalt with the aggregate proposed for
 3 use.

4 **660-3 WEATHER AND SEASONAL LIMITATIONS**

5 Do not place any asphalt surface treatment between October 15 and March 16, except for
 6 asphalt surface treatment that is to be overlaid immediately with asphalt plant mix.

7 Apply asphalt material only when the surface to be treated is dry and when the atmospheric
 8 temperature is above 50°F in the shade away from artificial heat.

9 When placing asphalt surface treatment that is to be immediately overlaid with asphalt plant
 10 mix, the seasonal and temperature limitations of Article 610-4 shall apply.

11 Do not apply asphalt material when the weather is foggy or rainy.

12 **660-4 SURFACE PREPARATION**

13 Clean the surface to be treated of all dust, dirt, clay, grass, sod and any other deleterious
 14 matter before application of the asphalt surface treatment.

15 **660-5 ACCEPTANCE OF ASPHALT MATERIALS**

16 The acceptance of asphalt materials will be in accordance with Section 1020-1.

17 **660-6 APPLICATION EQUIPMENT**

18 Use asphalt application equipment that meets Article 600-5.

19 Apply aggregate by the use of a self-propelled, pneumatic-tire aggregate spreader capable of
 20 maintaining a specified rate with a uniform application for the width of asphalt material being
 21 covered. Tailgate spreaders will not be permitted. Areas that are inaccessible to the
 22 aggregate spreader may be covered by hand spreading or other acceptable methods.

23 **660-7 APPLICATION OF ASPHALT MATERIALS**

24 The grades, rates of application and the temperature that the asphalt material is to be applied
 25 shall be within the limits shown in Table 660-1.

26 Base the required rates of application on the volume of material at the application
 27 temperature.

Section 660

**TABLE 660-1
MATERIAL APPLICATION RATES AND TEMPERATURES**

Type of Coat	Grade of Asphalt	Asphalt Rate Gal/SY Total	Application Temp. °F	Aggregate Size	Aggregate Rate Lb/SY Total
Mat	CRS-2 or CRS-2P	0.35 - 0.45	150 - 175	No. 6M ^{A,C}	30 - 35
	CRS-2 or CRS-2P	0.30 - 0.35	150 - 175	No. 67	35 - 45
	CRS-2 or CRS-2P	0.45 - 0.50	150 - 175	No. 5 ^{B,C}	45 - 50
	CRS-2 or CRS-2P	0.30 - 0.40	150 - 175	No. 78M ^{A,C}	15 - 20
Straight Seal	CRS-2 or CRS-2P	0.35 - 0.40	150 - 175	No. 78M	16 - 22
	CRS-2 or CRS-2P	0.35 - 0.40	150 - 175	Lightweight	9 - 12
Split Seal	CRS-2 or CRS-2P	0.5 - 0.60	150 - 175	No. 78M	30 - 35
	CRS-2 or CRS-2P	0.45 - 0.60	150 - 175	Lightweight	18 - 20
Triple Seal	CRS-2 or CRS-2P	0.60 - 0.75	150 - 175	No. 78M	45 - 51
	CRS-2 or CRS-2P	0.60 - 0.75	150 - 175	Lightweight	27 - 29
Sand Seal	CRS-2 or CRS-2P	0.22 - 0.30	150 - 175	Blotting Sand	12 - 15

1 **A.** Use No. 6M or No. 78M aggregate for retreatment before an overlay on existing
2 pavement.

3 **B.** Use No. 5 aggregate for initial treatment on new construction.

4 **C.** Article 660-9 includes more details regarding variations of the types of coats.

5 **660-8 APPLICATION OF AGGREGATES**

6 The size of the aggregate shall be as shown in Table 660-1 for the mat coat or the type of seal
7 coat to be constructed. The rate of application for mat and seal aggregates shall be within the
8 limits shown in Table 660-1. When directed, weigh a sufficient number of truck loads of
9 aggregate before spreading to verify that the rate of application is within the required limits
10 and use **ASTM D5624** to determine rate of application.

11 **660-9 CONSTRUCTION METHODS**

12 **(A) Asphalt Mat Coat**

13 The surface on which the mat coat is to be applied shall be approved by the Engineer
14 before the mat coat liquid asphalt is applied.

15 Place a string line guide for application equipment unless otherwise permitted. Place the
16 mat coat in full-lane widths, unless otherwise permitted.

17 Immediately follow the application of mat liquid asphalt with the spreading of the
18 aggregate. No more than 5 minutes can elapse from the time the liquid asphalt is applied
19 and the rolling is completed when using CRS-2. No more than 4 minutes can elapse from
20 the time the liquid asphalt is applied and the rolling is completed when using CRS-2P or
21 CRS-2L.

22 Test mat coat aggregate, have approved and drained of free moisture before use. Spread
23 the aggregate uniformly at the required rate and correct all non-uniform areas before
24 rolling.

25 Roll immediately after the aggregate is uniformly spread. Rolling consists of at
26 least 3 complete coverages with two 5 to 8 ton steel-wheel rollers. Continue rolling until
27 the aggregate is thoroughly keyed into the mat liquid asphalt. Do not allow crushing of
28 the aggregate or picking up of the material by the rollers. A combination steel-wheel and
29 pneumatic-tire roller will not be permitted. Use 2 individual steel-wheel rollers. The
30 3 coverages shall be completed within 5 minutes of the spraying of the mat liquid asphalt.

31 At the beginning of each mat liquid asphalt application, spread a paper over the end of
32 the previously completed mat coat and begin the asphalt application on the paper. After
33 application, remove and dispose of the paper.

1 After the aggregate is thoroughly seated, broom all excess aggregate off of the surface of
2 the mat coat as directed. Traffic may be permitted on the mat coat immediately after the
3 rolling and brooming is complete.

4 Correct defects or damage to the mat coat before the application of seal coat or plant mix
5 overlay. The seal coat or plant mix may be applied the same day the mat coat is placed
6 provided the mat coat has been satisfactorily applied and rolled.

7 **(B) Asphalt Seal Coat**

8 Use the type of seal coat as required by the contract. Test seal coat aggregates, obtain
9 approval and drain of free moisture before use.

10 Adjust the aggregate rates to provide a sufficient quantity of cover material to be spread
11 over the surface of the seal coat preventing traffic damage, where it is necessary to permit
12 traffic on sections of a completed seal coat.

13 Perform rolling of each layer immediately after the aggregate has been uniformly spread.
14 Rolling will consist of at least 3 complete coverages with 2 pneumatic-tire rollers
15 followed by at least one complete coverage with a 5 to 8 ton steel-wheel roller. These
16 coverages shall be completed within 5 minutes of the asphalt emulsion being placed
17 when using CRS-2. When CRS-2P or 2L is used all roller coverages shall be completed
18 within 4 minutes of the asphalt emulsion being placed. Do not allow crushing of the
19 aggregate or picking up of the material by the rollers. The use of a combination steel-
20 wheel and pneumatic-tire roller will be permitted instead of the 5 to 8 ton steel-wheel
21 roller.

22 The requirements of Subarticle 660-9(A) will apply to the width of seal coat construction,
23 application of liquid asphalt and aggregate and the construction of joints. When directed,
24 broom excess aggregate material from the surface of the seal coat and apply blotting sand
25 in accordance with Section 818.

26 The construction of the various types of seal coats will be in accordance with the
27 following additional requirements:

28 (1) Straight Seal

29 Apply liquid asphalt material to the existing surface followed immediately by
30 an application of granite or lightweight aggregate using Table 660-1 and
31 requirements in the contract. Uniformly spread the full required amount of aggregate
32 in one application and correct all non-uniform areas before rolling.

33 Immediately after the aggregate has been uniformly spread, perform rolling as
34 previously described.

35 (2) Split Seal

36 Apply liquid asphalt material to the existing surface followed immediately by an
37 application of granite or lightweight aggregate using Table 660-1 and requirements
38 in the contract ensuring each is uniformly placed over the existing surface and rolled
39 as previously described.

40 Immediately after the first application of seal aggregate has been made uniform and
41 rolled, apply the second application of the required amount of liquid asphalt material
42 and seal coat aggregate or blotting material as defined in Article 1012-3 and roll as
43 previously described.

Section 660

1 (3) Triple Seal

2 Follow the procedure outlined in Subarticle 660-9(B)(2) with the exception that only
3 granite or lightweight aggregate can be used on the second application. Apply liquid
4 asphalt material and granite aggregate, lightweight aggregate or blotting material as
5 defined in Article 1012-3 as a third layer and roll as previously described.

6 Instead of the No. 78M or lightweight stone, blotting material as defined in
7 Article 1012-3 may be used for the top aggregate layer with an application rate of
8 approximately 6 to 12 lb/sy.

9 (4) Slurry Seal

10 (a) Mix Requirements

11 Submit to the Engineer a mix design and results of the wear loss by the wet track
12 abrasion test (WTAT) as prepared by an approved testing laboratory. The
13 WTAT will be performed in accordance with ASTM D3910. The wear loss by
14 the Wet Track Abrasion Test shall not be greater than 100 g/sf. Apply the wear
15 loss to the asphalt content limits designated on the JMF.

16 Place a test strip for approval by the Engineer before beginning the work. Once
17 the consistency of the mix has been approved by the Engineer, maintain the total
18 water content within 3% of the approved blend during the course of operation.

19 Submit a mix design for each type slurry. The gradation of the mix produced
20 shall conform to the job mix range. The asphalt content (residual asphalt) shall
21 not vary by more than 1.5% from the approved mix design.

TABLE 660-2 SLURRY SEAL GRADATION CRITERIA									
Type	Percentage of Total by Weight Passing								Remarks
	3/8"	#4	#8	#16	#30	#50	#100	#200	
B	100	90-100	65-90	45-70	30-50	18-33	10-21	5-15	Design Asphalt Content,% #: 8.5-13
C	100	90-100	70-90	32-54	23-38	16-29	9-20	5-15	Design Asphalt Content,% #: 8.5-11.5

22 (b) Sampling Requirements

23 Samples for gradation will be taken from aggregate stockpiles designated by the
24 Contractor for use. Take samples for asphalt content and total water content
25 from the completed mixture. Samples of aggregate, filler and emulsion for wet
26 track abrasion check test will be taken at the job site. The frequency of
27 sampling and testing will be established by the Engineer based upon the
28 Department's acceptance program and local conditions encountered.

29 (c) Equipment

30 Combine the mixing and spreading equipment in a single mobile operating unit.
31 Attach a burlap drag 19" wide to the back of the unit for the purpose of
32 smoothing the slurry seal. Equip the mobile unit with an approved feeder that
33 will accurately meter or otherwise introduce a predetermined amount of material
34 into the mixer simultaneously with the aggregate. Use the feeder whenever
35 mineral filler is added to the mix. Equip the mobile unit with a water pressure
36 system and fog type spray bar capable of completely fogging the surface to that
37 slurry seal is to be applied. Use a mobile unit capable of an operative speed of
38 at least 60 ft/min and that has sufficient storage capacity to mix and apply
39 a minimum of 5 tons of slurry.

- 1 (i) Mixer
- 2 Use a continuous flow type mixer capable of delivering water and
- 3 a predetermined proportion of aggregate and asphalt emulsion to
- 4 a revolving multiblade mixer tank. Use a mixer that discharges the
- 5 thoroughly mixed product on a continuous basis and in that the blades of the
- 6 mixing unit are capable of thoroughly blending all ingredients.
- 7 (ii) Spreader
- 8 Use a spreader equipped with a flexible type squeegee positioned in contact
- 9 with the pavement surface and designed to apply a uniform spread with
- 10 a minimum loss of slurry.
- 11 (iii) Auxiliary Equipment
- 12 Provide hand squeegees, shovels and other hand equipment as necessary to
- 13 perform work in areas that are inaccessible to the unit.
- 14 (d) Construction Methods
- 15 (i) Preparation of Surface
- 16 Thoroughly clean the surface upon which slurry seal is to be applied of all
- 17 loose material, vegetation, silt spots and other objectionable materials
- 18 immediately preceding application by either brooming or the use of
- 19 compressed air.
- 20 (ii) Application
- 21 Wet aggregate immediately before mixing with the emulsion. The Engineer
- 22 may direct that the surface of the pavement be fogged with water
- 23 (approximately 0.05 gal/sy) immediately preceding the pass of the spreader.
- 24 Provide a slurry mixture of a consistency such that it rolls in the spreader
- 25 box in a continuous mass. Slurry that segregates in the spreader box, so that
- 26 flowing of liquids (water and emulsion) is evident, is not acceptable and
- 27 shall not be applied. The liquid portion of slurry mixture shall not flow
- 28 from either the spreader box or the applied slurry. Evidence of such flow is
- 29 sufficient cause for rejection of the applied material. Place the slurry on the
- 30 road in full lane widths up to and including 12 ft. Use a mechanical device
- 31 such as an auger to distribute the slurry mix in the spreader box.
- 32 Correct excess buildup of slurry on longitudinal and transverse joints.
- 33 Do not open treated areas to traffic until such time as the slurry seal has
- 34 cured to the extent that it will no longer be damaged by traffic. The applied
- 35 slurry mixture shall be uniform in texture and not flush under traffic.
- 36 Correct any areas not satisfactory to the Engineer. Nothing contained
- 37 herein is intended to relieve the Contractor from sharing in the
- 38 responsibility and performance of the treatments, if a failure occurs before
- 39 acceptance of the contract. Article 105-17 is amended accordingly.
- 40 Do not apply slurry seal surface course on surfaces containing ponding
- 41 water and the minimum surface temperature shall be 50°F.
- 42 The Engineer may require the surface area to that the slurry has been
- 43 applied by hand to be rolled using a pneumatic-tire type roller. Operate the
- 44 roller at an approximate tire pressure of 50 psi and subject the paved area to
- 45 a minimum of 2 coverages.
- 46 If oversize aggregate is encountered in the stockpile, immediately cease
- 47 operation and remove the oversize aggregate by screening.

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1 (iii) Thickness of Application

2 The average minimum thickness of application shall be at least 3/16" for
3 Type B and at least 5/16" for Type C, unless otherwise specified.

4 In the event of a test failure on compatibility or WTAT (loss greater than
5 100 g/sf) for a sample of material being applied to the road, take corrective
6 action before start-up of another day's run. If the sample taken following
7 adjustment fails the compatibility or WTAT, cease application on the road.
8 Maintain responsibility for furnishing additional compatibility or WTAT
9 results and field application site(s). Resume application when the
10 acceptability of seal is clearly demonstrated.

11 The disposition of rejected material will be subject to the approval of the
12 Engineer.

13 (5) Sand Seal

14 Place the fully required amount of asphalt material in one application and
15 immediately cover with the seal coat aggregate. Uniformly spread the fully required
16 amount of aggregate in one application and correct all non-uniform areas before
17 rolling.

18 Immediately after the aggregate has been uniformly spread, perform rolling.

19 When directed, broom excess aggregate material from the surface of the seal coat.

20 When the sand seal is to be constructed for temporary sealing purposes only and will
21 not be used by traffic, other grades of asphalt material meeting Articles 1020-5
22 and 1020-6 may be used instead of the grade of asphalt required by Table 660-1
23 when approved.

24 (C) Asphalt Mat and Seal

25 Construct the mat coat in accordance with Subarticle 660-9(A) using the size aggregate
26 required by the contract.

27 Construct the seal coat in accordance with Subarticle 660-9(B) using the type seal
28 required by the contract.

29 (D) Cape Seal

30 Construct the cape seal by applying a seal coat followed by applying a slurry seal as
31 defined in Subarticle 660-9(B).

32 **660-10 MAINTENANCE AND PROTECTION**

33 Maintain and protect the asphalt surface treatment until it is accepted by the Department.
34 Make all necessary repairs in such a manner as to preserve the uniformity of the surface.

35 **660-11 MEASUREMENT AND PAYMENT**

36 *Asphalt Surface Treatment, Mat Coat, No. ___ Stone; Asphalt Surface Treatment, ___ Seal*
37 *and Asphalt Surface Treatment, Mat and Seal* will be measured and paid at the contract unit
38 price per square yard. *Asphalt Surface Treatment, ___ Seal* includes *Straight Seal, Split*
39 *Seal, Triple Seal, Slurry Seal, Sand Seal* and *Cape Seal*. Payment at the above prices will be
40 made for replacing any satisfactorily completed asphalt surface treatment when such
41 replacement has been made necessary by defects in subgrade or base constructed by others.

42 When the Engineer directs that the rate of application of asphalt material be decreased below
43 the minimum rate shown in Table 660-1, no reduction in compensation will be made.

1 When the Engineer directs that the rate of application of asphalt material be increased above
 2 the maximum rate shown in Table 660-1, compensation to the Contractor will be made in the
 3 amount of 5 cents plus the verified cash cost to the Contractor at the point of delivery for each
 4 gallon of asphalt material, measured at application temperature, necessitated by the increase.

5 *Blotting Sand* will be paid in accordance with Article 818-4.

6 *Asphalt Surface Treatment, Slurry Seal* materials placed in stockpiles or on the road not
 7 meeting the required tolerances may be accepted at a reduced price if it is not considered
 8 detrimental to the life of the treatment by the Engineer in accordance with Article 105-3. The
 9 following price adjustment schedule will be used for *Asphalt Surface Treatment, Slurry Seal*
 10 when appropriate:

11 (A) One percent reduction in the bid price per square yard for each 1/10% the asphalt content
 12 is out of tolerance.

13 (B) One-quarter percent price adjustment in the bid price per square yard for each 1% that the
 14 aggregate gradation is out of the job mix range.

15 (C) One-half percent reduction in the bid price per square yard for each gram per square foot
 16 of wet-track abrasion test (WTAT) loss between 101 g and 200 g. Material having a loss
 17 greater than 200 g will not be accepted for payment.

18 (D) One percent reduction in the bid price per square yard for each 1% water in excess of the
 19 approved water content plus 3%.

20 Price adjustments under Subarticles 660-11(A) through 660-11(D) above shall apply
 21 concurrently; however, price adjustment will not apply in the event the material is rejected.

22 Furnishing and applying prime will be paid as provided in Article 600-9 for *Prime Coat*.

23 Payment will be made under:

Pay Item	Pay Unit
Asphalt Surface Treatment, Mat Coat, No. __ Stone	Square Yard
Asphalt Surface Treatment, ____ Seal	Square Yard
Asphalt Surface Treatment, Mat and Seal	Square Yard

24 **SECTION 661**
 25 **ULTRA-THIN BONDED WEARING COURSE**

26 **661-1 DESCRIPTION**

27 Produce and place an Ultra-thin Bonded Wearing Course (UBWC), including an application
 28 of a warm Polymer-Modified Emulsion Membrane (PMEM) followed immediately with
 29 an UBWC hot mix asphalt overlay. Spray polymer-modified emulsion membrane
 30 immediately before applying hot mix asphalt.

31 Provide and conduct the QC and required testing for acceptance of the UBWC in accordance
 32 with the contract.

33 **661-2 MATERIALS**

34 Refer to Division 10.

Item	Section
Anti-strip Additives	1012-1(G)
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)
Mineral Filler	1012-1(D)
Polymer Modified Asphalt Binder	1020-2
Reclaimed Asphalt Shingles (RAS)	1012-1(E)

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1 Use either PG 70-28 or PG 76-22 binder in the mix design. Conform to Section 620. Ensure
2 that the asphalt binder is compatible with the PMEM and the existing pavement.

3 **661-3 COMPOSITION OF MIX**

4 Do not use crystalline limestone, crystalline-dolomitic limestone or marble for aggregates and
5 do not use RAP. Use a mixture of coarse and fine aggregate, asphalt binder, mineral filler and
6 other additives when required. Size, uniformly grade and combine in such proportions such
7 that the resulting mixture meets the gradation and physical requirements of Tables 661-1 and
8 661-2. Use the mix design and optimum asphalt content for *Ultra-thin Bonded Wearing*
9 *Course Mix Design Guidelines* on file with the Materials and Tests Unit and available upon
10 request. RAS may be used in accordance with Subarticle 610-3(A).

11 Submit in writing a mix design and proposed JMF targets for each required mix type and
12 combination of aggregates to the Engineer for review and approval at least 20 days before
13 start of asphalt mix production. Submit the mix design and proposed JMF targets on forms
14 and in a format approved by the Department and in accordance with applicable requirements
15 of Article 610-3.

16 Establish the JMF target values within the mix design criteria specified in Table 661-2for the
17 particular type mixture.

18 Have on hand at the asphalt plant, the approved mix design and JMF issued by the
19 Department, before beginning the work.

20 The JMF for each mixture shall remain in effect until modified in writing by the Engineer,
21 provided the results of QMS tests performed on material currently being produced conform
22 with specification requirements. If a change in sources of aggregate materials needs to be
23 made, a new mix design and JMF will be required before the new mixture is produced. When
24 unsatisfactory results or other conditions make it necessary, the Engineer may establish a new
25 JMF.

26 Determine and certify compatibility of all asphalt emulsion, asphalt binder and aggregate
27 components.

Sieves (mm)	% Passing by Weight
12.5	100
9.50	85 - 100
4.75	28 - 44
2.36	17 - 34
1.18	13 - 23
0.600	8 - 18
0.300	6 - 13
0.150	4 - 10
0.075	3.0 - 7.0

**TABLE 661-2
UBWC MIX DESIGN CRITERIA**

Property	Requirement
Asphalt Content, %	4.6 - 5.8
Draindown Test, AASHTO T 305	0.1% max
Moisture Sensitivity, AASHTO T 283 ^A	85% min
Application Rate, lb/sy	70 lb/sy
Approximate Application Depth, in.	5/8"
Asphalt PG Grade, AASHTO M 320	PG 70-28 or PG 76-22

- 1 A. Specimens for T 283 testing are to be compacted using the Superpave gyratory
2 compactor. The mixtures shall be compacted using 100 gyrations to achieve
3 specimens approximately 95 mm in height. Use mixture and compaction
4 temperatures recommended by the binder supplier.

5 **661-4 CONSTRUCTION METHODS**

6 **(A) Equipment**

7 Use asphalt mixing plants in accordance with Article 610-5. Furnish paving machine
8 with the following capabilities:

- 9 (1) Self-priming paving machine capable of spraying the Polymer-Modified Emulsion
10 Membrane, applying the hot asphalt concrete overlay and screeding the surface of
11 the mat to the required profile and cross section in one pass at any rate between
12 30 and 92 ft/minute.
- 13 (2) Receiving hopper, feed conveyor, storage tank for Polymer-Modified Emulsion
14 Membrane material, PMEM emulsion single variable-width spray bar and a variable
15 width, heated, vibratory-tamping bar screed.
- 16 (3) Screed with the ability to be crowned at the center both positively and negatively and
17 have vertically and horizontally adjustable extensions to accommodate the desired
18 pavement profile and widths.
- 19 (4) Sprayer system capable of accurately and continuously monitoring the rate of spray
20 and providing a uniform application across the entire width to be overlaid.
- 21 (5) Use pavers equipped with an electronic screed control that will automatically control
22 the longitudinal profile and cross slope of the pavement. Control the longitudinal
23 profile through the use of either a mobile grade reference(s), including mechanical,
24 sonic and laser grade sensing and averaging devices, an erected string line(s) when
25 specified, joint matching shoe(s), slope control devices or the approved methods or
26 combination of methods. Unless otherwise specified, use a mobile grade reference
27 system capable of averaging the existing grade or pavement profile over
28 at least a 30 ft distance or by non-contacting laser or sonar type ski with
29 at least 4 referencing stations mounted on the paver at a minimum length of 24 ft.
30 Establish the position of the reference system such that the average profile grade is
31 established at the approximate midpoint of the system. The transverse cross slope
32 shall be controlled as directed by the Engineer.

33 Use an erected fixed stringline for both and longitudinal profile and cross slope control
34 when required by the contract. When an erected fixed string line is required, furnish and
35 erect the necessary guide line for the equipment. Support the stringline with grade stakes
36 placed at maximum intervals of 25 ft for the finished pavement grade.

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1 Use the 30 ft minimum length mobile grade reference system or the non-contacting laser
2 or sonar type ski with at least 4 referencing stations mounted on the paver at a minimum
3 length of 24 ft to control the longitudinal profile when placing the initial lanes and all
4 adjacent lanes of all layers, including resurfacing and asphalt in-lays, unless other
5 specified or approved. A joint matching device (short 6"shoes) may be used only when
6 approved.

7 Use the automatic slope control system unless otherwise approved. The Engineer may
8 waive the use of automatic slope controls in areas where the existing surface (subgrade,
9 base, asphalt layer, etc.) exhibits the desired cross slope of the final surface. The
10 Engineer may also waive the use of automatic slope controls in areas where the use of
11 such equipment is impractical due to irregular shape or cross section (such as
12 resurfacing). When the use of the automatic slope controls is waived, the Engineer may
13 require the use of mobile grade references on either or both sides of the paver. Manual
14 screed operation will be permitted in the construction of irregularly shaped and minor
15 areas, subject to approval. Waiver of the use of automatic screed controls does not
16 relieve the Contractor of achieving plan profile grades and cross slopes.

17 In the case of malfunction of the automatic screed control equipment, the paver may be
18 manually operated for the remainder of the workday provided this method of operation
19 produces acceptable results. Do not resume work thereafter until the automatic system is
20 functional.

21 The Engineer will waive the requirement for use of pavers for spreading and finishing
22 where irregularities or obstacles make their use impractical. Spread, rake and lute the
23 mixture by hand methods or other approved methods in these areas.

24 Operate the paver as continuously as possible. Pave intersections, auxiliary lanes and
25 other irregular areas after the main line roadway has been paved, unless otherwise
26 approved.

27 Compact the wearing course with a steel double drum asphalt roller(s) with a minimum
28 weight of 10 tons. Maintain rollers in reliable operating condition and equip with
29 functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller
30 drums. Supply adequate roller units and compact promptly following the placement of
31 the material.

32 Request approval of equipment before the start of any work. Maintain all equipment and
33 tools in satisfactory working condition at all times.

34 **(B) Surface Preparation**

35 Perform the following items before the commencement of paving operations.

36 (1) Protect and cover manhole covers, drains, grates catch basins and other such utility
37 structures with plastic or building felt before paving and reference for location and
38 adjustment after paving.

39 (2) Remove thermoplastic traffic markings symbols, characters or other markings
40 greater than 1/4" in thickness on the existing pavement.

41 (3) Clean and completely fill pavement cracks and joints greater than 1/4" wide. Do not
42 overband the existing cracks and joints. Apply sealant per manufacturer's
43 recommendation.

44 (4) Fill surface irregularities greater than 1" deep with a material approved by the
45 Engineer.

46 (5) Thoroughly clean the entire pavement surface, giving specific attention to
47 accumulated mud and debris. Pressurized water and/or vacuum systems may be
48 required to ensure a clean surface.

(C) Application of Ultra-thin Bonded Wearing Course

Produce, transport to the site and place the UBWC in accordance with Section 610, except as otherwise provided below.

Use only one asphalt binder PG grade for the entire project, unless the Engineer gives written approval.

Do not place ultra-thin bonded wearing course between October 31 and April 1, when the pavement surface temperature is less than 50°F or on a wet pavement. In addition, when PG 76-22 binder is used in the JMF, place the wearing course only when the road pavement surface temperature is 60°F or higher and the air temperature in the shade away from artificial heat is 60°F or higher.

Apply the ultra-thin bonded wearing course mixture at the rate per square yard as shown in Table 661-2 for the mix type shown in the plans.

Spray the polymer-modified emulsion membrane at a temperature of 140°F to 180°F. Provide a uniform application across the entire width. Determine the rate of application (typically 0.15 to 0.25 gal/sy) by the mix design and current pavement condition for the specified project. Ensure the rate of application is approved by the Engineer before beginning work.

Do not allow wheels or other parts of the paving machine to touch the polymer-modified emulsion membrane before the hot mix asphalt concrete wearing course is applied.

Place the hot asphalt concrete wearing course over the full width of the polymer-modified emulsion membrane. Apply the hot mix asphalt concrete at a temperature of 300°F to 330°F and within a maximum of 3 seconds immediately after the application of the membrane.

Before opening to traffic, allow the pavement to sufficiently cool after the rolling operation to resist damage to the pavement.

(D) Compaction

Compact the wearing course with at least 2 passes of a steel double drum asphalt roller before the material temperature has fallen below 185°F. Do not allow the rollers to remain stationary on the freshly placed asphalt concrete. Compact immediately following the placement of ultra-thin bonded wearing course. A release agent (added to the water system) may be required to prevent adhesion of the fresh mix to the roller drum and wheels. Compact in the static mode.

661-5 QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

Produce the ultra-thin hot mix asphalt in accordance with Section 609.

661-6 MEASUREMENT AND PAYMENT

Ultra-thin Bonded Wearing Course will be measured and paid by the actual number of tons of mixture incorporated into the completed and accepted work. The hot mix asphalt pavement will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Application of Ultra-thin Hot Mix Asphalt will be measured and paid at the contract unit price per square yard. In measuring this quantity, the length will be the actual length constructed, measured along the surface. The width will be the width required by the contract or directed by the Engineer.

Polymer Modified Asphalt Binder for Plant Mix will be paid in accordance with Article 620-4. Asphalt binder price adjustments when applicable will be based on Grade PG 64-22, regardless of the grade used.

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1 Where PG 76-22 is being used in the production of ultra-thin, the grade of asphalt binder to be
2 paid will be PG 70-28, unless otherwise approved.

3 The above prices and payments will be full compensation for all work covered by this section
4 including, but not limited to, furnishing all materials, producing, weighing, transporting,
5 placing and compacting the polymer modified asphalt emulsion; maintaining the ultra-thin
6 bonded wearing course until final acceptance of the project; performing QC as specified in the
7 contract; and making any repairs or corrections to the surface of the pavement or adjacent
8 landscape that may become necessary.

9 Payment will be made under:

Pay Item	Pay Unit
Ultra-thin Bonded Wearing Course, UBWC	Ton
Application of Ultrathin Hot Mix Asphalt	Square Yard

SECTION 663

HOT IN-PLACE RECYCLED ASPHALT CONCRETE

663-1 DESCRIPTION

13 This work shall consist of hot in-place recycling of the existing asphalt concrete surface by
14 heating and softening the existing asphalt pavement with indirect heat, loosening the heated
15 pavement by hot milling to the depth specified in the plans, adding a plant produced hot mix
16 asphalt admixture, if required, applying a rejuvenating agent, thoroughly remixing the
17 material in a pugmill, leveling, relaying and compaction of the hot in-place recycled asphalt
18 mixture. Use a continuous, single train, single pass, multi-step process to accomplish this
19 work.

20 Provide and conduct the QC and required testing for acceptance of the hot in-place recycled
21 mixture in accordance with the contract.

663-2 MATERIALS

(A) Hot Mix Asphalt Admixture

24 Determine the type and amount of plant produced hot mix asphalt (HMA) admixture to
25 be added to the recycled mixture, subject to the approval of the Engineer. The HMA
26 admixture shall be a plant mixture of asphalt binder and aggregate(s) meeting Division 10
27 as shown below. The aggregate in the admixture may be a single standard size aggregate
28 or a combination of aggregate sizes as needed. Provide enough binder content for the
29 admixture such that the aggregate particles are fully coated. Provide a gradation and
30 binder content for the admixture such that when blended with the other mix components,
31 the hot in-place recycled mix properties shall meet the mix design criteria for the
32 applicable mix type specified in the plans, unless otherwise approved by the Engineer.

33 Refer to Division 10.

Item	Section
Anti-strip Additives	1012-1(G)
Asphalt Binder	1020-2
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)

(B) Asphalt Rejuvenating Agent

Use an asphalt rejuvenating agent in accordance with Table 663-1.

Property	Minimum	Maximum
Viscosity, 77°F, SFS, ASTM D244	20 SFS	125 SFS
Sieve, %, ASTM D244	-	0.10%
Storage Stability, 24 hr, %, ASTM D244	-	1%
Residue from distillation, % ^A	60%	-
Oil Distillate, Volume %	-	5
Tests on Residue and Rolling Thin-Film Oven Tests:^B		
Penetration @ 77°F, 5 sec.	300	-
Torsional Recovery 39.7°F, %	20%	-

A. ASTM D244 except that the maximum temperature shall be 350°F held for 20 minutes.

B. The residue from distillation shall be subject to the standard rolling thin film oven test.

663-3 COMPOSITION OF MIXTURE**(A) General Mix Design**

Prepare and submit a proposed hot in-place recycled mix design and JMF to the Engineer at least 20 days before beginning work in accordance with Article 610-3 except as modified herein. Submit a proposed mix design for the admixture if an admixture is required.

Sample the existing pavement by coring, or other methods approved by the Engineer, to determine representative characteristics and properties of the existing pavement for use in mix design preparation. Take at least one sample every 2,000 lf of each lane. Provide samples for QA testing when requested by the Engineer. Take all QA test samples in the presence of the Engineer and at locations approved by the Engineer.

Perform and document a mix design in accordance with the Department's policies and procedures. Contact the Asphalt Design Engineer at the Materials and Tests Unit for copies of these procedures, if needed. Establish the proposed hot in-place recycled mix design such that the hot in-place recycled mix properties are within the design criteria for the type mix specified, unless otherwise approved by the Engineer. Submit the mix designs on forms and in the format approved by the Department. Once the proposed mix designs are approved, the Engineer will provide approved JMFs.

In addition to applicable mix design data required in Subarticle 610-3(A), the data shall include, but not be limited to, the proposed percent admixture, if needed, admixture components, gradation, binder grade, binder content, percent anti-strip additive in admixture, percent existing pavement (RAP), gradation and binder content of existing pavement, percent rejuvenating agent, penetration of recovered binder from total mix and all mix design properties and calculations.

(B) Mix Design Criteria

The finished asphalt pavement shall be a uniform mixture composed of the existing in-place asphalt pavement, asphalt rejuvenating agent and new hot mix asphalt admixture, if required. The hot in-place recycled asphalt mix shall meet Article 610-3 for the mix type specified, excluding the maximum percentage of allowable RAP and as modified herein.

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1 The proposed hot in-place recycled mix design shall be established such that the hot in-
2 place recycled mix properties will meet applicable gradation and mix design
3 requirements of Table 610-2 and Table 610-3 for the mix type specified, except as
4 modified herein, unless otherwise approved by the Engineer.

5 Add an asphalt rejuvenating agent at a rate that yields a completed mixture with the
6 penetration value as specified in Table 663-1, unless otherwise approved by the Engineer.

7 (C) Job Mix Formula (JMF)

8 If the proposed mix design is approved, the Engineer will provide a JMF for the hot
9 in-place recycled asphalt mix. The JMF will be established within the design criteria in
10 Tables 610-2 and 610-3, unless otherwise approved by the Engineer.

11 If the hot in-place recycled mix design is approved, the Engineer will provide a JMF for
12 the admixture if admixture is required. Produce the completed admixture in accordance
13 with the JMF requirements for gradation and binder content in the contract.

14 Samples of the completed recycled mixture may be taken by the Department on a random
15 basis to determine if the PG grading on the recovered asphalt binder is in accordance with
16 AASHTO M 320 for the grade specified. If the grading is determined to be a value other
17 than required for the specified mix type, the Engineer may require the Contractor to
18 adjust the grade and the percentage of additional asphalt binder, asphalt rejuvenator and
19 the blend of reclaimed material and admixture to bring the PG grade to the specified
20 value for the required mix type in accordance with Table 610-3.

21 663-4 EQUIPMENT

22 (A) General

23 Equipment used to recycle the existing asphalt surface shall be designed and built for this
24 specific purpose. The equipment shall be capable of a single pass, multi-step operation
25 that includes multi-step heating, milling, introducing rejuvenating agent, introducing hot
26 mix asphalt admixture, if required, mixing the new material with the reclaimed material
27 in a separate on-board chamber, redistributing the recycled material, leveling and
28 compacting the mixture.

29 (B) Pre-heating Units

30 Supply pavement pre-heaters capable of uniformly heating the asphalt pavement to
31 a temperature high enough to remove excess moisture, to allow milling of the existing
32 pavement material to the designated plan depth without excessive fracturing of aggregate
33 particles, without charring the existing asphalt and without producing undesirable
34 pollutants. Equip the heating mechanism so that the heat application is completely under
35 an enclosed or shielded hood. Protect adjacent landscape from heat damage and repair
36 any damage that may occur. The unit shall be adjustable in width. Ensure that the
37 heaters overlap the completed adjacent lane by at least 6" to create a hot bond at the
38 longitudinal joint.

39 (C) Milling/Blending Unit

40 Supply a self-propelled processing unit containing the following:

- 41 (1) A recycling machine equipped with additional heaters conforming to the same
42 requirements as the pre-heaters.
- 43 (2) A unit capable of uniformly loosening the existing asphalt pavement to the depth
44 specified. Care shall be taken to ensure that milling or pavement reclaiming does not
45 degrade the aggregates but only loosens the heated existing pavement.

- 1 (3) A controlled system for adding and uniformly blending a rejuvenating agent at
 2 a predetermined rate with the reclaimed mix during the remixing and leveling
 3 operation. The metering equipment shall be capable of measuring in gallons. The
 4 application rate in gallons, for the added material, shall be synchronized with the
 5 machine ground speed to provide a uniform application. The actual rate used may be
 6 adjusted as determined.
- 7 (4) A blending unit consisting of a twin shafted pugmill capable of uniformly adding
 8 new hot mix asphalt admixture, if required, at a rate established by the mix design.
 9 The unit shall be capable of thoroughly mixing the loosened asphalt pavement,
 10 asphalt rejuvenating agent and new hot mix asphalt admixture, if required, at the
 11 pugmill to produce a uniform mixture.
- 12 (5) A unit capable of auguring the heated and loosened material into a windrow at the
 13 center of the machine before entry into the blending unit.
- 14 (6) A paving machine meeting Article 610-8, except as modified herein, shall be used to
 15 redistribute the remixed material over the width being processed and finished to
 16 produce a uniform cross section and surface. The paving machine shall be capable
 17 of screeding the full width of the remixed material. Provide and use automatic
 18 screed controls in accordance with Subarticle 661-4(A), unless otherwise approved
 19 by the Engineer.
- 20 (7) The recycling train shall be capable of maintaining an average production rate of at
 21 least one lane mile per day.
- 22 (8) The reheating and remixing units shall meet all State and local air quality emission
 23 standards for mobile sources.

24 **(D) Compaction Equipment**

25 Use rollers meeting Article 610-9 and capable of achieving the specified density and
 26 surface requirements.

27 **663-5 CONSTRUCTION METHODS**

28 Hot in-place recycled mixtures shall not be produced or placed during rainy weather or when
 29 the air temperature measured in the shade away from artificial heat at the location of the
 30 paving operations is less than 50°F. Do not place surface course material that is to be the
 31 final layer of pavement between December 15 and March 16 of the next year.

32 Before heating and remixing operations, the pavement shall be cleaned of all loose material.
 33 Power brooms shall be used and supplemented when necessary by hand brooming or other
 34 cleaning operations, as required, to bring the surface to a clean, suitable condition free of
 35 deleterious material.

36 The pavement surface shall be evenly heated, loosened and remixed to the lines, grades and
 37 depths shown on the plans. Heating shall be controlled to ensure uniform heat penetration
 38 without overheating, cooking or sooting of the asphalt pavement. The milled material shall be
 39 picked up, mixed with an asphalt rejuvenator and asphalt admixture, if needed, in a pugmill
 40 and then distributed and leveled by a conventional paving machine. The temperature of the
 41 milled material shall not be more than 325°F when measured immediately behind the milling
 42 unit. The temperature of the remixed material shall not be less than 235°F directly behind the
 43 screed.

44 The heating operation shall extend at least 4" beyond the width of remixing on both sides.
 45 When a pass is made adjacent to a previously placed mat, the longitudinal joint shall extend at
 46 least 2" into the previously placed mat.

Section 663

1 The layer thickness of the hot in-place recycled specified in the Plans or Contract Proposal
2 shall be the compacted in-place thickness of the rejuvenated recycled mixture layer including
3 any admixture. The depth of milling of the existing surface shall be such that the depth as
4 specified on the plans is within ± 1/4", unless otherwise approved by the Engineer.

5 The asphalt rejuvenator shall be applied uniformly to the mixed material before remixing in
6 the pugmill. The rate of application of rejuvenator will be as specified on the JMF approved
7 by the Engineer based upon the Contractor's proposed mix design.

8 The remixed asphalt pavement shall be compacted immediately after it has been spread and
9 leveled, while it is still in a workable condition.

10 Density control may be by either core samples or nuclear density control in accordance with
11 the Department's procedures. Density for hot in-place recycled mixes shall meet Table 610-6
12 for the specified mix type. The maximum specific gravity tested in accordance with
13 AASHTO T 209 will be determined by procedures specified in the Department's *HMA/QMS*
14 *Manual*.

15 The compacted surface of the completed and accepted pavement structure shall meet
16 Article 610-12.

17 The Contractor shall take precautions needed to protect the adjacent landscape from heat
18 damage. Damaged landscape shall be repaired or replaced.

19 **663-6 MEASUREMENT AND PAYMENT**

20 *Hot In-Place Recycled Asphalt Concrete, Type _____* will be measured and paid by the square
21 yard in the completed and accepted work.

22 *Emulsified Asphalt Rejuvenating Agent* to be paid will be measured by the metered quantity in
23 gallons used in all completed and accepted work and will be paid at the contract price per
24 gallon.

25 *Hot Mix Asphalt Admixture*, when required, will be measured by being weighed in trucks on
26 a certified weighing device and documented on load tickets and will be paid at the contract
27 unit price per ton.

28 Asphalt binder in accepted work will be measured and paid in accordance with Section 620.

29 The above prices and payments will be full compensation for all work covered by this section
30 including, but not limited to, furnishing all materials, producing, weighing, transporting,
31 placing and compacting the recycled pavement; maintaining the finished course until final
32 acceptance of the project; performing QC as specified in the contract; and making any repairs
33 or corrections to the surface of the pavement or adjacent landscape that may become
34 necessary.

35 Payment will be made under:

Pay Item	Pay Unit
Hot In-Place Recycled Asphalt Concrete, Type _____	Square Yard
Emulsified Asphalt Rejuvenating Agent	Gallon
Hot Mix Asphalt Admixture	Ton

SECTION 665
MILLED RUMBLE STRIPS ON ASPHALT CONCRETE
SHOULDERS

1

2

3

4 **665-1 DESCRIPTION**

5 Construct rumble strips on asphalt concrete shoulders in accordance with the plans and as
 6 directed by the Engineer. Work includes, but is not limited to, furnishing all labor, equipment
 7 and all incidentals necessary to complete the work satisfactorily and disposing of milled
 8 material.

9 **665-2 EQUIPMENT**

10 Provide equipment consisting of a rotary-type cutting head with an outside diameter of no
 11 more than 24" and at least 16" long. Provide a cutting head that has the cutting tips arranged
 12 to provide a relatively smooth cut. Provide a cutting head on its own independent suspension
 13 from that of the power unit to allow the tool to self align with the slope of the shoulder or any
 14 irregularities in the shoulder surface.

15 Provide a cutting tool equipped with guides to provide consistent alignment of each cut in
 16 relation to the roadway and to provide uniformity and consistency throughout the project.

17 **665-3 CONSTRUCTION METHODS**

18 Demonstrate the ability to achieve desired surface inside each depression without tearing or
 19 snagging the asphalt before beginning the work.

20 Provide rumble strips that have finished dimensions of 7" \pm 1/2" wide in the direction of
 21 travel and are at least 16" long measured perpendicular to the direction of travel. Provide
 22 rumble strips having depressions with a concave circular shape with a minimum 1/2" depth at
 23 center (no more than an allowable depth 5/8"). Place rumble strips in relation to the roadway
 24 according to the patterns shown in the plans.

25 Material resulting from the operation becomes the property of the Contractor. Remove and
 26 dispose of this material in accordance with Section 802.

27 At the end of each working day remove all equipment to a location where it does not present
 28 a traffic hazard, clean pavement and reopen work area to traffic.

29 **665-4 MEASUREMENT AND PAYMENT**

30 *Milled Rumble Strips (Asphalt Concrete)* will be measured and paid at the contract unit price
 31 per linear foot for the actual number of linear feet of shoulder, measured longitudinally along
 32 the surface of each shoulder, where rumble strips have been constructed.

33 Payment will be made under:

Pay Item	Pay Unit
Milled Rumble Strips (Asphalt Concrete)	Linear Foot

DIVISION 7 CONCRETE PAVEMENTS AND SHOULDERS

SECTION 700 GENERAL REQUIREMENTS FOR PORTLAND CEMENT CONCRETE PAVEMENT

700-1 DESCRIPTION

Perform the work covered by this section, which includes, but is not limited to, the construction of a single course non-reinforced Portland cement concrete pavement on a prepared base, in accordance with these *Standard Specifications* and with the lines, grades, thicknesses and typical sections shown on the plans or as directed.

The Department accepts concrete pavement with respect to strength, thickness and ride quality on a lot by lot basis subject to adjusted unit prices as provided in Sections 710 and 720.

Use any combination of equipment that shall effectively perform the necessary construction operations. Ensure the equipment is at the job site sufficiently ahead of the start of construction operations for the Engineer to examine thoroughly and approve.

Maintain all equipment in a satisfactory operating condition while in use on the work.

Before placing concrete pavement, submit for approval a Process Control Plan addressing all operations necessary in the production and placement of concrete pavement.

700-2 CONCRETE PRODUCTION EQUIPMENT

Use batch plants, central mix plants and truck mixers that meet Section 1000.

700-3 CONCRETE HAULING EQUIPMENT

Transport concrete to the point of placement either in a truck agitator, a truck mixer operating at agitating speed or in non-agitating equipment meeting the provisions below. Bottom or belly dump equipment is prohibited. Provide and secure material covers on the equipment bodies for protection against detrimental environmental conditions.

Prevent the accumulation of hardened concrete in the delivery vehicles. Discharge all flushing water before charging with the next concrete load.

When using non-agitating hauling equipment, provide bodies which are smooth, watertight, metal containers with rounded internal corners equipped with vibrators and gates to discharge the concrete without segregation or damage.

For concrete hauled in a transit mix (ready mix) truck, use Table 1000-2 to determine the maximum elapsed time. For concrete hauled in other equipment, the elapsed time shall be 60 minutes or less, unless otherwise approved. Define the "elapsed time" as the period from first contact between mixing water and cement until the completion of the entire operation including placing, finishing, micro-surfacing and any necessary corrective work.

Deliver the concrete to the work site in a thoroughly mixed and uniform mass.

If at discharge, the concrete is not thoroughly mixed and homogeneous, the hauling distance, charging sequence, size of load, mixing time or any combination thereof shall be altered to meet these requirements; otherwise, use other equipment capable of delivering a thoroughly mixed and uniform concrete mass.

Section 700

1 **700-4 PREPARATION OF SUBGRADE AND BASE**

2 Prepare the subgrade and base beneath Portland cement concrete pavement in accordance
3 with the applicable sections of these Specifications and with a grading tolerance of $\pm 1/4$ "
4 from the established grade on mainline lanes and a grading tolerance of $\pm 1/2$ " in all other
5 areas. Use approved automatically controlled grading and paving equipment to produce final
6 subgrade and base surfaces meeting the lines, grades and cross sections required by the plans
7 or as directed. When in the judgment of the Engineer the use of such equipment is
8 impractical, this requirement will be waived.

9 Dampen the surface of the base at the time the concrete is placed. Sprinkle the base when
10 necessary to provide a damp surface. Ensure that no free water or ponding is present at the
11 time of concrete placement. Correct all damaged areas in the subgrade or base before placing
12 concrete.

13 Do not allow traffic on the underlying asphalt courses other than necessary local traffic and
14 essential construction equipment as authorized by the Engineer.

15 Unless otherwise approved, use and maintain a braided metal cable stringline reference to
16 control the profile and alignment of the concrete pavement. Monitor the stringline for
17 accuracy and tautness. Set pins at a distance no farther than 50 ft apart. When located on
18 a vertical curve, set pins no farther than 25 ft apart.

19 **700-5 PLACING CONCRETE**

20 **(A) General**

21 Use a slip form paver to place concrete except where impractical due to irregular areas or
22 areas of existing pavement adjacent to the proposed pavement.

23 Place concrete only in the presence of the Engineer or his authorized representative.

24 Handle concrete so as to prevent segregation and keep free from mud, soil or any other
25 foreign matter.

26 Where finishing operations must be completed after dark, provide acceptable artificial
27 light in accordance with Section 1413.

28 Do not pave when any of the following conditions exist:

29 (1) A descending air temperature in the shade and away from artificial heat reaches
30 35°F . Do not resume paving until an ascending air temperature in the shade and
31 away from artificial heat reaches 35°F .

32 (2) The subgrade or base course is frozen.

33 (3) Aggregates to be used in the mix contain frozen particles.

34 (4) Air temperature in the shade is 90°F and rising or the concrete temperature is greater
35 than 95°F .

36 Where additional pavement, aggregate or soil must be placed adjacent to new pavement
37 by machine methods, do not place it until the concrete has attained a compressive
38 strength of at least 3,500 psi.

39 Construction equipment or hauling equipment will not be allowed over the pavement
40 until the concrete has attained a compressive strength of 3,500 psi.

41 Spread the concrete uniformly over the entire area without segregation. Perform the
42 spreading with a mechanical spreader independent of the paver except where hand
43 methods are necessary due to pavement design, equipment breakdown or other
44 emergencies.

(B) Slip Form Paver Method

Use a slip form paver that is an approved self-propelled machine(s) designed to spread, consolidate, screed and float finish the concrete in one complete pass of the machine to provide a smooth, dense and homogeneous pavement with minimal hand finishing. Use a slip form paver equipped with forms of sufficient length and rigidity to support the edges of the slab to minimize hand finishing. Use slip form pavers equipped with both horizontal and vertical automatic controls. Operate the paver with continuous forward movement and coordinate all operations of mixing, delivering and spreading the concrete to provide uniform progress and minimize stopping and starting of the paver.

Provide concrete that has sufficient cohesion to prevent appreciable slumping at the edges of each slab. Longitudinal straight edge tolerance of 1/4" in 10 ft shall apply to the area within 6" of the edge. Edge slump shall be limited to no more than 1/4".

(C) Fixed Form Method

Apply this section to all paving operations where a slip form paver is not being used.

Use forms made of metal and of such section and design that they will adequately support the concrete and the construction equipment.

Use forms that have a depth not less than the edge thickness of the pavement to be constructed and not more than 1" greater than the edge thickness of the pavement to be constructed. Use a form which has the base width at least equal to the height of the form.

Use a form in which the top face does not vary from a true plane more than 1/8" in 10 ft and the upstanding leg does not vary more than 1/4".

Use straight forms that have at least 3 pin pockets per 10 ft in length and at least 2 pin pockets per 5 ft in length.

Use form pins that are metal and capable of holding the forms rigidly in place during construction operations. The Engineer may require pinholes in the base to be sealed before placing subsequent pavement.

Connect the form sections by a locking joint that will keep the forms free from vertical and horizontal movement.

Use straight forms 10 ft in length on tangents and on curves having a radius of 200 ft or more. For curves having a radius of between 50 ft and 200 ft use either straight forms 5 ft in length or flexible forms. Use flexible forms for curves having a radius of less than 50 ft.

Clean all forms before they are set. Oil all forms before placing concrete. Check the bearing of the forms and correct all areas of inadequate bearing.

Remove all rejected forms immediately from the project.

Set forms a sufficient distance in advance of the point where the concrete is being placed to provide for a continuous operation in placing the concrete and for proper inspection of line and grade.

All forms used for construction joints shall meet this section except provisions shall be made for inserting dowel bars where required.

700-6 VIBRATING CONCRETE

Uniformly vibrate the concrete after it has been spread. Consolidate the full width and depth of the Portland cement concrete in a single pass.

Vibrators for full width vibration of concrete may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Attach the vibrators to the spreader or the finishing machine, or mount the vibrators on a separate carriage.

Section 700

1 Furnish an electronic vibrator monitoring device, displaying the operating frequency of each
2 individual vibrator on the paving equipment. Operate the electronic vibrator monitoring
3 device in areas where the mainline, ramp or loop pavement exceeds 600 ft in length. Record
4 the time, station location, paver track speed and operating frequency of each individual
5 vibrator after every 25 ft of paving or after each 5 minute time interval has elapsed. Provide
6 a report of the vibrator data to the Engineer daily for the first 3 days of paving and weekly
7 thereafter. The Engineer may determine that more frequent submissions are necessary,
8 particularly if equipment is malfunctioning.

9 Set the internal vibrators to approximately mid slab depth and provide a locking device to
10 avoid contact with any joint, load transfer device, tie bar, subgrade or side form. Provide an
11 operating position locking device so that no part of the vibrating unit can be lowered to the
12 extent that it will come in contact with dowel bars, dowel bar assemblies or tie bars while
13 paving.

14 Set the horizontal spacing of vibrators to the manufacturer's recommendations, but in no case
15 exceed 16" from center to center.

16 Operate internal and spud vibrators within a frequency range of 3,500 to 8,000 vpm and
17 surface vibrators within a frequency range of 3,500 to 6,500 vpm. Operate vibrators to avoid
18 separation of the mix ingredients. A reduction in vibrator frequency may be required when
19 the forward motion of the paver is reduced to avoid separation of the mix. Either discontinue
20 the use or remove from contact with the concrete, the machine mounted vibrators, whenever
21 the forward motion of the machinery is stopped.

22 Should the electronic monitoring device fail to operate properly, immediately check the
23 vibrators manually in the presence of the Engineer or his representative. If the vibrators are
24 functioning properly, paving may continue. Repair the monitoring device within 3 production
25 days or suspend paving.

26 **700-7 FINISHING**

27 Finish concrete pavement or concrete shoulders in accordance with Article 710-6 or 720-7,
28 respectively. Do not use excessive water for finishing.

29 **700-8 PROTECTION OF PORTLAND CEMENT CONCRETE PAVEMENT**

30 **(A) General**

31 Protect the Portland cement concrete pavement from environmental conditions. Remove
32 and replace concrete pavement damaged as a result of environmental conditions.

33 Use protective covering that will protect the surface of the freshly placed pavement from
34 rain or cold weather readily available each day at the location of each proposed day's
35 operation before beginning work. Store an adequate quantity of these materials at the
36 paving train.

37 **(B) Cold Weather**

38 When the temperature is anticipated to drop below 35°F within any 24 consecutive hours
39 of the curing period, defined in Subarticle 700-9(A), insulate the Portland cement
40 concrete pavement to prohibit the concrete from cooling at a rate greater than 5°F per
41 hour and prevent the surface temperature from dropping below 35°F during the curing
42 period.

43 **(C) Hot Weather**

44 When the anticipated daily high temperature is above 90°F, place the concrete at the
45 coolest temperature practical. Control concrete temperatures to assure proper placing,
46 consolidation, finishing, curing and to prevent plastic shrinkage cracking.

(D) Rain

When rain appears imminent, stop all paving operations, and ensure all available personnel protect the surface of the unhardened concrete. Failure to properly protect the concrete pavement may constitute cause for removal and replacement of the damaged pavement.

700-9 CURING**(A) General**

Immediately after finishing operations have been completed and surface water has disappeared, cover all exposed surfaces of the pavement by one of the methods herein.

Apply the selected curing method to the edges of the pavement immediately after the forms are removed.

Use a curing period of 3 curing days for straight cement mix designs and 7 curing days for pozzolan mix designs. Define a "curing day" as any consecutive 24 hour period, beginning when the manipulation of each separate mass has been completed, during which the air temperature adjacent to the mass does not fall below 40°F.

(B) Membrane Curing Compound

After final finish and immediately after the free surface moisture has disappeared, use a minimum application rate of 0.0067 gal/sf when the application equipment is mechanically operated. Provide an inline flow-metering device to ensure the proper application rate is provided. Apply the curing compound such that puddling or ponding does not occur on the fresh concrete surface.

Use mechanically operated application equipment designed to apply a uniformly agitated continuous flow of the curing compound at the prescribed rate to all concrete surfaces.

Hand spraying shall only be permitted for irregular widths or shapes and surfaces exposed by removal of forms. The rate of application for these areas shall be 0.01 gal/sf.

Do not expose newly placed concrete for more than 30 minutes before being covered with curing compound. Failure to cover the surfaces of the concrete shall be cause for immediate suspension of the paving operation.

Protect the membrane curing compound film at all times during the curing period and repair any damage immediately. Ensure a sufficient amount of polyethylene film, burlap or other approved material is available to provide for protection of the concrete during rain or when the application equipment fails to apply the curing compound uniformly to all surfaces.

Reapply curing compound to any concrete surfaces that received heavy rainfall within 3 hours after initial application.

(C) Polyethylene Film

Spread the sections of the film in a manner that will not damage the finished pavement surface. Securely tape or provide lap joints for the sections that are at least 12" wide, and take suitable precautions to prevent the circulation of air beneath the film. Cover all exposed surfaces and beyond the edge of the pavement surface.

Use black or dark plastic sheets when the daily high ambient temperature is between 40°F and 60°F. Use white opaque reflective plastic sheet when the daily ambient temperature is above 60°F. Plastic sheets will meet ASTM C171.

Check the film for damage when it is spread and during the curing period. Repair or replace any damaged sections immediately.

Section 700

1 (D) Burlap

2 Spread the sections of burlap in a manner that will not damage the finished pavement
3 surface. Provide lap joints that are at least 6" wide.

4 Use an amount of burlap that is not less than 12 oz. per running yard based on
5 a 40" width. Use either one layer of Class 4 burlap or 2 layers of Class 1, 2 or 3 burlap.

6 Saturate the burlap thoroughly before placing on the concrete and keep thoroughly wet
7 throughout the curing period.

8 **700-10 REMOVING FORMS**

9 Do not remove forms from freshly placed concrete for at least 12 hours after placement and
10 until the concrete has hardened sufficiently to resist spalling, cracking or any other damage.
11 Repair any honeycombed areas along the sides or edges of the slab by filling with mortar
12 immediately after the forms have been removed. Use mortar consisting of one part cement to
13 2 parts fine aggregate.

14 **700-11 JOINT CONSTRUCTION**

15 (A) General

16 Construct all joints in accordance with these *Standard Specifications* and the details
17 shown on the plans. Saw all transverse joints and seal them with joint sealer in
18 accordance with the dimensions and details shown in the contract. Seal joints in
19 accordance with Article 700-12.

20 Use an early entry dry-cutting sawing system. Ensure an adequate amount of sawing
21 equipment is available to match the production and concrete paving operations. At least
22 one standby sawing unit is recommended. Construct the joint groove using a 1/8" saw
23 blade to a minimum depth of 4" or the design thickness divided by 3 whichever is less.
24 Perform sawing as soon as the concrete has hardened sufficiently without undercutting,
25 spalling and raveling to control random cracking. Complete all saw cutting before
26 7 hours has elapsed from the time of concrete placement.

27 Saw the concrete pavement as soon as it can support the weight of the equipment and
28 operator without disturbing the final finish. Saw joints in a neat, vertical straight line
29 without chipping, spalling, tearing or disturbing the final finish.

30 Immediately after sawing the joint to the dimensions shown on the plans, completely
31 remove the resulting slurry from the joint without damaging the adjacent concrete.
32 Immediately reapply curing membrane to areas damaged by the sawing operation.

33 Deviations from the method of joint construction specified in the contract requires prior
34 approval in writing. Such approval is conditional and is subject to obtaining satisfactory
35 results.

36 The Engineer may order any concrete pavement or shoulder where uncontrolled cracking
37 has occurred before final acceptance to be removed and replaced at no cost to the
38 Department. Where permitted, the Contractor may be allowed to repair the cracking in
39 a manner acceptable to the Engineer.

40 Before placing either concrete pavement or concrete shoulders adjacent to a previously
41 placed pavement, cover the transverse joint opening on the edge of the existing slab to
42 prevent intrusion of grout into the opening.

43 (B) Transverse Contraction Joints

44 Construct transverse contraction joints in accordance with the details, dimensions and
45 intervals as shown on the plans.

1 (C) Longitudinal Contraction Joints

2 Construct longitudinal contraction joints in all pavements wider than 16 ft in accordance
3 with the details and dimensions shown on the plans.

4 (D) Transverse Construction Joints**5 (1) General**

6 Construct transverse construction joints by use of an approved form at the end of
7 each day's operations (planned joint) or whenever the placing of concrete is
8 suspended for more than 30 minutes (emergency joint).

9 (2) Planned Transverse Construction Joints

10 Locate this type of joint at the same spacing required for contraction joints. Use
11 dowel bars of the size and spacing shown on the plans.

12 (3) Emergency Transverse Construction Joints

13 Use this type of joint when the placing of concrete is suspended for more than
14 30 minutes. Use tie bars of the size and spacing shown on the plans.

15 Do not change the spacing of contraction joints due to emergency construction joints.
16 Locate the emergency construction joints at least 6 ft from any contraction joint or
17 planned construction joint.

18 (E) Longitudinal Construction Joints

19 Construct longitudinal construction joints using tie bars in accordance with the details
20 shown on the plans.

21 (F) Transverse Expansion Joints

22 Construct transverse expansion joints in accordance with the details shown on the plans
23 utilizing an approved joint assembly.

24 (G) Verification of Dowel Bar Alignment

25 Use either properly secured dowel baskets or a dowel bar inserter, provided the ability to
26 correctly locate and align the dowels at the joints is demonstrated as described below.

27 Provide a calibrated magnetic imaging device that will document dowel bar location and
28 alignment. Calibrate the magnetic imaging device to the type and size dowel bar used in
29 the work. Use this device as a process control and make necessary adjustment to ensure
30 the dowels are placed in the correct location.

31 Scan at least 25% of the joints in the initial placement or 1.0 mile of pavement,
32 whichever is greater, at random intervals, as selected by the Engineer, throughout the
33 pavement each time the paving train is mobilized. Mark scanned joints on the pavement.

34 Scan all joints in this initial placement if the dowel bars exhibit longitudinal translation
35 (side shift), horizontal translation, vertical translation (depth), horizontal skew or vertical
36 tilt, above the allowable tolerances defined below. In addition, continue scanning no less
37 than 25% of the joints until it is established that the dowel bar inserter or secured dowel
38 basket assemblies are consistently placing the dowel bars at the correct location and
39 meeting the tolerances defined in Table 700-1. Once the engineer determines that
40 consistency is established, the contractor may reduce the percentage of scanned joints to
41 no less than 10%. Any time inconsistency in the placement of the dowel bars becomes
42 evident, additional scanning may be required up to 100% of the joints. Materials and
43 Tests Unit will provide Quality Assurance and random verification scans during the
44 initial concrete placement to verify the Contractor's scan results. The QA frequency will
45 be at least 10% of the Contractor's scan.

Section 700

1 If consistency of the proper dowel bar alignment cannot be established within
2 a reasonable time frame, the Engineer will have the option of suspending the paving
3 operation.

4 Provide a report of the scanned joints within 48 hours of completing the day's
5 production. The report should include the station and lane of the joint scanned, as well as
6 the horizontal location, depth, longitudinal translation (side shift), horizontal skew and
7 vertical tilt, of each dowel bar in the joint. If a dowel bar inserter is used, the joint score
8 described below should also be provided in the report.

9 Longitudinal translation (side shift) is defined as the position of the center of the dowel
10 bar in relation to the sawed joint. The maximum allowable longitudinal translation (side
11 shift) is 2".

12 Horizontal translation is defined as difference in the actual dowel bar location from its
13 theoretical position as detailed in the standard details. The maximum allowable
14 horizontal translation is 2".

15 Vertical translation (depth) is the difference in the actual dowel bar location from the
16 theoretical midpoint of the slab. The maximum allowable vertical translation is 1/2"
17 higher than the theoretical midpoint and 1" lower than the theoretical midpoint.

18 Dowel bar misalignment, either vertical tilt or horizontal skew is defined as the difference
19 in position of the dowel bar ends with respect to each other. Vertical tilt is measured in
20 the vertical axis whereas horizontal skew is measured in the horizontal axis.

21 If a dowel bar inserter is used, determine a joint score for each joint scanned. The joint
22 score is a measure of the combined effects from the dowel's horizontal skew or vertical
23 tilt. The joint score is determined by summing the product of the weight shown in the
24 Table 700-1 and the number of bars in each misalignment category and adding one. The
25 vertical tilt and horizontal skew should be evaluated and the greater misalignment shall
26 be used in determining the joint score. If 2 lanes are poured simultaneously, the joint
27 score is calculated for the 24-ft section.

Misalignment Category, mm	Weight
$0 \leq d \leq 15$	0
$15 < d \leq 20$	2
$20 < d \leq 25$	4
$25 < d \leq 38$	5
$38 \leq d$	10

28 **A.** Where **d** is the individual dowel bar misalignment.

29 A joint that has a joint score of 10 or greater will be considered locked.

30 When a locked joint as defined above is discovered, scan the 2 joints immediately
31 adjacent to the locked joint. If either of the adjacent joints are deemed to be locked,
32 provide a written proposal to address the dowel misalignment for each locked joint.
33 No corrective action should be performed without written approval.

34 **700-12 SEALING JOINTS**

35 **(A) General**

36 Seal all joints with an approved low modulus silicone sealant in the presence of the
37 Engineer.

38 Install backer rod and sealant in accordance with the details shown in the plans and the
39 manufacturer's recommendations.

1 Any failure of the joint material will be cause for rejection. Repair the failed joint
2 material as approved by the Engineer.

3 When requested, have a representative of the silicone sealant manufacturer present on the
4 project during the sealing operation.

5 **(B) Age of Pavement**

6 Do not seal the joints until the concrete is at least 14 calendar days old.

7 Do not perform final sawing and sealing of concrete pavement joints until after surface
8 testing, correction of surface deficiencies and all adjacent earth and paved shoulder
9 construction has been completed.

10 **(C) Temperature**

11 Do not place joint sealant when the air temperature near the joint is less than 45°F or
12 is 45°F and falling.

13 **(D) Sealing the Joint**

14 Immediately after sawing the joint to the dimensions as shown on the plans, completely
15 remove the resulting slurry from the joint by flushing with a jet of water under pressure.
16 Use sand blasting to clean joint faces before applying sealant. Make as many passes with
17 a sand blaster as are necessary to provide a clean joint wall.

18 Blow all joints clear of deleterious materials with air using a nozzle pressure of at least
19 90 psi before installing the backer rod. Use rotary screw compressors for this purpose
20 that are equipped with traps capable of removing water and oil from the air. Maintain the
21 traps in accordance with manufacturer's instructions.

22 Apply sealer only on thoroughly clean and dry joints. Place the sealer to closely conform
23 to dimensions shown on the plans. Any unreasonable deviation will be cause for
24 rejection.

25 **(E) Cleaning Pavement**

26 After a joint has been sealed, remove surplus joint sealer on the pavement as soon as
27 possible.

28 **700-13 USE OF NEW PAVEMENT OR SHOULDER**

29 Traffic or other heavy equipment will not be allowed on the concrete pavement or shoulder
30 until the estimated compressive strength of the concrete using the maturity method has
31 exceeded 3,500 psi, unless otherwise permitted. Estimate the compressive strength of
32 concrete pavement in accordance with ASTM C1074 unless otherwise specified.

33 Furnish thermocouples or thermistors and digital data logging maturity meters that
34 automatically compute and display the maturity index in terms of a temperature-time
35 factor (TTF). The maturity meters must be capable of storing at least 28 days worth of data
36 and exporting data into an Excel® spreadsheet. Submit the proposed equipment to the
37 Engineer for approval.

38 When establishing a strength-maturity relationship, perform compressive tests at ages 1, 3, 7,
39 14 and 28 days in accordance with AASHTO T 22.

40 Use the TTF maturity function to compute the maturity index from the measured temperature
41 history of the concrete. Set the datum temperature at - 10°C to calculate the TTF in
42 Equation 1 of ASTM C1074.

Section 700

1 Establish and submit a strength-maturity relationship in conjunction with each concrete
2 pavement mix design. Determine the TTF corresponding to the strength-maturity relationship
3 at 3,500 psi, TTF. Any changes to plant operations, material sources or mix proportions will
4 affect the strength-maturity relationship. If any changes occur during production, develop
5 a new strength-maturity relationship unless otherwise directed.

6 Verify the strength-maturity relationship during the first day's production. Use the TTF
7 developed at mix design TTF to verify the production strength-maturity relationship. Verify
8 the strength-maturity relationship at least every 10 calendar days or when production is
9 suspended for more than 10 days. If the verification sample's compressive strength when
10 tested at TTF is less than 3,500 psi, immediately suspend early opening of traffic on pavement
11 that has not obtained TTF until a new strength-maturity relationship is developed.

12 No permanent traffic will be allowed on the pavement until construction of the joints,
13 including all sawing, sealing and curing that is required, has been completed.

14 Take particular care to protect the exposed pavement edges and ends.

15 **700-14 CONTRACTOR'S RESPONSIBILITY FOR PROCESS CONTROL**

16 Perform process control sampling and testing of concrete materials and operations in
17 accordance with Article 1000-3. The Contractor's roadway foreman and all personnel
18 involved in the batching, sampling, testing and acceptance of Portland cement concrete
19 pavement shall be Department certified Portland cement concrete pavement technicians.

20 **700-15 ACCEPTANCE TESTS FOR CONCRETE**

21 **(A) Responsibility**

22 The Engineer will conduct acceptance sampling and testing of concrete. Provide access
23 to all materials to be sampled and tested. The following tests will be performed on both
24 concrete pavement and concrete shoulders to determine acceptance.

25 **(B) Lot Definition**

26 A lot for acceptance purposes is defined and described in Article 710-4.

27 **(C) Air Content**

28 The air content of the concrete will be determined on the roadway at a frequency
29 established by the Engineer and in accordance with Subarticle 1000-3(B). The sample
30 taken for determination of air content will be obtained immediately after the concrete has
31 been discharged on the road.

32 Concrete failing to meet specification requirements for air content will be subject to
33 rejection.

34 **(D) Slump**

35 The slump of the concrete will be determined in accordance with AASHTO T 119 at
36 a frequency established by the Engineer. The sample taken for determination of slump
37 will be obtained immediately after the concrete has been discharged on the road.

38 When the slump of the concrete is questionable by visual observation, do not place the
39 concrete on the road until tested for slump by the Engineer.

40 Concrete failing to meet specification requirements for slump will be subject to rejection.

(E) Compressive Strength

Determine the compressive strength of concrete using one set of two 6" x 12" cylinders at 28 calendar days. Test samples will be made by the Engineer from the concrete as it comes from the mixer. The samples will be made and cured in accordance with AASHTO T 23. Test specimens will be tested by the Engineer in accordance with AASHTO T 22. Furnish curing facilities for the test samples in accordance with Section 725.

(F) Thickness

The thickness of the pavement will be determined by measurement of cores in accordance with AASHTO T 148.

Take 4" diameter cores in the presence of the Engineer. The Engineer will take immediate possession of the cores. Take the cores when the concrete has attained a compressive strength of at least 3,500 psi and at least 72 hours have elapsed since placement of the pavement. If the concrete has not attained a compressive strength of at least 3,500 psi, the gross vehicle weight rating of vehicles supporting the coring operation may not exceed 7,000 lb. Take cores no later than 30 days after the pavement has been placed. The core locations for each lot will be selected at random by the Engineer.

Patch all core holes within 72 hours of taking the core, using an approved nonshrink grout compatible with the pavement or shoulder concrete.

(G) Surface Smoothness

Perform acceptance testing for surface smoothness on concrete pavements in accordance with Article 710-7. The Engineer will have a representative present during all testing and will take possession of the results at the completion of each day's testing.

700-16 MEASUREMENT AND PAYMENT

Remove and repair defects and damage to underlying asphalt course, Portland cement concrete and joints at no cost to the Department.

SECTION 710 CONCRETE PAVEMENT

710-1 DESCRIPTION

Perform the work covered by this section, including, but not limited to, designing the concrete mix; furnishing and placing concrete; furnishing of all admixtures and additives; constructing all joints and furnishing joint materials; marking the pavement; curing the pavement and furnishing all curing materials; furnishing concrete necessary for making test beams and cylinders; performing maturity testing; coring and patching the pavement; calibrating and checking the operation of batching equipment; taking actions necessary to prevent or to repair cracking; sawing and sealing joints; verifying dowel bar alignment; removing and replacing of defective pavement; and constructing Portland cement concrete pavement in accordance with these *Standard Specifications* and with the lines, grades and dimensions shown on the plans.

710-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Agents	1026
Dowels and Tie Bars	1070-6
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000

Section 710

Item

Water

Section

1024-4

1 **710-3 COMPOSITION OF CONCRETE**

2 Design the concrete mix in accordance with Section 1000.

3 Before placement, produce a trial batch through the plant. The Engineer will make
4 compressive and flexural samples from the trial batch for testing at 1, 3, 7, 14 and 28 days of
5 age. Until the trial batch meets 650 psi flexural strength and 4,500 psi compressive strength,
6 the Engineer will make acceptance samples for flexural and compressive tests for mix placed.
7 If the trial batch test results meet strength requirements, flexural samples representing placed
8 concrete will be discarded, and compressive samples will be used for acceptance. If the trial
9 batch does not meet strength requirements, flexural samples will be used for acceptance until
10 plant produced mix meets strength requirements.

11 If any major change as defined in Section 1000-3 is made to the mix design, this process shall
12 be initiated again.

13 **710-4 ACCEPTANCE OF CONCRETE**

14 The Department will test the concrete pavement for acceptance with respect to compressive
15 strength and thickness on a lot by lot basis in accordance with Article 700-15 and the
16 requirements herein.

17 For all concrete pavement, including mainline, shoulders, ramps, tapers, intersections,
18 entrances, crossovers and irregular areas not otherwise defined, produce a lot consisting of
19 1,333.3 sy or fraction thereof placed within 28 calendar days. From each lot, the Engineer
20 will make at least one set of two 6" x 12" cylinders from a randomly selected batch of
21 concrete. The average compression strength of the 2 cylinders is considered one test. If
22 Department personnel make and test additional sets of cylinders for a lot, all sets will be
23 averaged with the original set to determine the strength. In the case of low strength, the
24 Engineer will perform an investigation.

25 **710-5 CONSTRUCTION METHODS**

26 Construct concrete pavement in accordance with Section 700.

27 Place concrete in 2 lane minimum widths in a single operation except as follows:

28 (A) Where the total number of lanes is an odd number, in which case one of the lanes may be
29 placed in a separate operation.

30 (B) Areas such as ramps or auxiliary lanes where the total width is less than 2 lanes.

31 **710-6 FINISHING**

32 Screed and float finish the concrete to the required cross section that minimizes or eliminates
33 hand finishing. Additional water for finishing will not be allowed. Hand finishing will not be
34 permitted except under the following conditions:

35 (A) Narrow widths or irregular areas, where operation of mechanical equipment is
36 impractical.

37 (B) If a breakdown of mechanical equipment occurs, hand methods may be used to finish
38 only that concrete deposited on the base before the breakdown.

39 (C) Abnormal circumstances of short duration subject to approval.

40 Produce a final finish on the pavement surface true to grade and uniform in appearance and
41 free of irregular, rough or porous areas.

1 Following the finishing of the pavement by screeding, floating and checking with
2 straightedges, further finish the surface of the pavement by burlap dragging or other
3 acceptable method to produce a uniform surface texture. Pull the burlap drag in a longitudinal
4 direction.

5 Produce the final surface finish on all mainline pavement, auxiliary lanes and ramps by
6 mechanical equipment for grooving plastic concrete which uses spring steel tines. Hand
7 finishing may be permitted when the use of mechanical equipment is impractical. Use
8 mechanical equipment that produces transverse grooves that are spaced at random intervals of
9 1/2", 5/8" or 3/4" center to center. Do not overlap adjacent grooving. Produce grooves in the
10 hardened surface, which are 0.08" to 0.12" wide and 0.15" to 0.25" deep.

11 After final finishing, hand finishing may be required on the edges of pavement and joints
12 whenever irregularities in surface texture or alignment occur. Care should be taken in hand
13 finishing pavement edges to avoid ridges or high places that will prevent water from draining
14 out of the transverse grooves.

15 The use of excessive water during the finishing operations will not be permitted.

16 Provide a textured surface with an average texture depth of 0.8 mm as tested in accordance
17 with ASTM E965 with no single test having a texture depth of 0.5 mm or less. The Engineer
18 will perform 4 randomly located tests in accordance with ASTM E965 within the initial
19 pavement lot of each mobilization. A "lot" is defined in Article 710-4. If the average of the
20 4 tests does not meet the above criteria, make appropriate changes to the surface texture
21 operations and test the next lot as detailed above. Once the surface texture process is
22 established to meet minimum texture requirements, maintain consistency within the operation
23 to provide the above minimum texture depth. Perform additional sand patch tests in
24 accordance with ASTM E965 when directed.

25 If the surface texture becomes damaged or reduced by rain or any other action, reestablish or
26 restore surface texture by an approved method.

27 **710-7 FINAL SURFACE TESTING**

28 Use an Inertial Profiler to measure the longitudinal pavement profile for construction quality
29 control and smoothness acceptance. Use a profiler with line laser technology as single-point
30 laser technology will not be allowed. Produce International Roughness Index (IRI) and Mean
31 Roughness Index (MRI) values for measuring smoothness.

32 Use testing and recording software to produce electronic inertial road profiles in a format
33 compatible with the latest version of FHWA's ProVAL (Profile Viewing and Analysis)
34 software.

35 The Inertial Profiler shall be calibrated and verified in accordance with the most current
36 version of AASHTO M 328. Provide certification documentation that the profiler meets
37 AASHTO M 328 to the Engineer before the first day the Inertial Profiler is used on the
38 project.

39 Configure the profiler to record the actual elevation of the pavement surface. Do not use the
40 profiler's internal IRI calculation mode. The profile data shall be filtered with a cutoff
41 wavelength of 300 ft. The interval at which relative profile elevations are reported
42 shall be 1".

43 Provide IRI data in accordance with most current version of ASTM E1926. Use personnel
44 trained to record and evaluate IRI data.

45 Provide a competent operator, trained in the operation of the Inertial Profiler. Operation of
46 the Inertial Profiling system shall conform to AASHTO R 57.

47 Provide the user selected Inertial Profiler settings to the Engineer for the project records.
48 Certification of the Inertial Profiling system shall conform to AASHTO R 56.

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- 1 Remove all objects and foreign material on the pavement surface prior to longitudinal
2 pavement profile testing.
- 3 Operate the profiler at any speed as per the manufacturer's recommendations, however, the
4 speed must be constant to within ± 3 mph of the intended speed and any required acceleration
5 should be as gradual as possible. For example, if the intended speed were 30 mph, the
6 acceptable range of speed for testing would be 27 to 33 mph.
- 7 Operate the Inertial Profiler in the direction of the final traffic pattern. Collect IRI data from
8 both wheel paths during the same run. It is permissible to collect data one wheel path at a
9 time if each wheel path is tested and evaluated separately. Define a "wheel path" as the 3 ft
10 from the edge of the travel lane. MRI values are the average of the IRI values from both
11 wheel paths. When using an inertial profiler that collects a single trace per pass, take care to
12 ensure that the measurements from each trace in a travel lane start and stop at the same
13 longitudinal locations. Unless otherwise specified, multiple runs are not necessary for data
14 collection.
- 15 Operate the automatic triggering method at all times unless impractical. A tape stripe or
16 traffic cone wrapped with reflective material may be used to alert the profiler's automatic
17 triggering sensor to begin data collection. The profiler shall reach the intended operating
18 speed before entering the test section. The runup and runout distances should be sufficient to
19 obtain the intended operating speed and to slow down after testing is completed.
- 20 Divide the pavement surface for the project into sections which represent a continuous
21 placement (i.e. the start of the project to bridge, intersection to intersection). Terminate
22 a section 50 ft before a bridge approach, railroad track, or similar interruption. (Separate into
23 0.10-mile sections).
- 24 The evaluation of the profiles will be performed on a section basis. A section is 0.10 mile of
25 a single pavement lane. For any section, which is less than 0.10 mile in length, the applicable
26 pay adjustment incentive will be prorated on the basis of the actual length.
- 27 Mark the limits of structures and other special areas to be excluded from testing using the
28 profiler's event identifier such that the exact locations can be extracted from the profile data
29 file during processing.
- 30 Unless otherwise authorized by the Engineer, perform all smoothness testing in the presence
31 of the Engineer. Perform smoothness tests on the finished surface of the completed project or
32 at the completion of a major stage of construction as approved by the Engineer. Coordinate
33 with and receive authorization from the Engineer before starting smoothness testing. Perform
34 smoothness tests within 7 days after receiving authorization. Any testing performed without
35 the Engineer's presence, unless otherwise authorized, may be ordered retested at the
36 Contractor's expense.
- 37 After testing, transfer the profile data from the profiler portable computer's hard drive to a
38 write once storage media (DVD-R or CD-R) or electronic media approved by the Engineer.
39 Label the disk or electronic media with the Project number, Route, file number, date, and
40 termini of the profile data. Submit the electronic data on the approved media to the Engineer
41 immediately after testing and this media will not be returned to the Contractor.
- 42 Submit documentation and electronic data of the evaluation for each section to the Engineer
43 within 10 days after completion of the smoothness testing. Submit the electronic files
44 compatible with ProVAL and the evaluation in tabular form with each 0.10-mile segment
45 occupying a row. Include each row with the beginning and ending station for the section, the
46 length of the section, the original IRI values from each wheel path, and the MRI value for the
47 section. Each continuous run for a section will occupy a separate table and each table will
48 have a header that includes the following: the project contract number, county, the roadway
49 number or designation, a lane designation, the dates of the smoothness runs, and the
50 beginning and ending station of the continuous run. Summarize each table at the bottom.

1 Traffic control and all associated activities included in the pavement smoothness testing of the
2 pavement surface will be the responsibility of the Contractor.

3 **(A) Acceptance for New Construction**

4 IRI and MRI numbers recorded in inches per mile will be established for each
5 0.10-mile section for each travel lane of the finished pavement surface designated by the
6 Contract.

7 Areas excluded from testing by the profiler will be tested by the Contractor and the
8 Engineer using a 10-ft stationary straightedge furnished by the Contractor. Any location
9 on the pavement selected by the Department shall be tested as well as all transverse
10 joints. Apply the straightedge parallel to the centerline of the surface. Do not exceed
11 1/8" variation of the surface being tested from the edge of the straightedge between any
12 2 contact points. Correct areas found to exceed this tolerance by removal of the defective
13 work and replacement with new material, unless other corrective measures are permitted.
14 Provide the work and materials required in the correction of defective work.

15 Table 710-1 provides the acceptance quality rating scale of pavement based on the final
16 rideability determination.

TABLE 710-1	
MRI PRICE ADJUSTMENT PER 0.10-MILE SECTION	
MRI after Completion (Inches Per Mile)	Price Adjustment Per Lane (0.10-Mile Section)
45.0 and Under	\$200.00
45.1-55.0	PA = 600 – (10 * MRI)
55.1-70.0	Acceptable (No Pay Adjustment)
70.1-90.0	PA = 650 – (10 * MRI)
Over 90.1	Corrective Action Required

17 This price adjustment will apply to each 0.10-mile section based on the Mean Roughness
18 Index (MRI), the average IRI values from both wheel paths.

19 When corrections to the pavement surface are required, the Engineer shall approve the
20 Contractor's method of correction. Methods of correction shall be diamond grinding,
21 remove and replace, or other methods approved by the Engineer. To produce a uniform
22 cross section, the Engineer may require correction to the adjoining traffic lanes or
23 shoulders. Corrections to the pavement surface, the adjoining traffic lanes and shoulders
24 will be at no cost to the Department.

25 Where corrections are made after the initial smoothness testing, the pavement will be
26 retested by the Contractor to verify that corrections have produced the acceptable ride
27 surface. No incentives will be provided for sections on which corrective actions have
28 been required. The Contractor will have one opportunity to perform corrective action(s).

29 **(B) Localized Roughness**

30 Areas of localized roughness shall be identified through the "Smoothness Assurance
31 Module" provided in the ProVAL software. Use the "Smoothness Assurance Module" to
32 optimize repair strategies by analyzing the measurements from profiles collected using
33 inertial profilers. The ride quality threshold for localized roughness shall be 125 in/mile
34 at the continuous short interval of 25 ft. Submit a continuous roughness report to identify
35 sections outside the threshold and identify all localized roughness, with the signature of
36 the Operator included with the submitted IRI trace and electronic files.

37 The Department will require that corrective action be taken regardless of final IRI.
38 Re-profile the corrected area to ensure that the corrective action was successful. If the
39 corrective action is not successful, the Department will assess a penalty or require
40 additional corrective action.

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1 Corrective work for localized roughness shall be approved by the Engineer before
2 performing the work and shall consist of either diamond grinding or other methods
3 approved by the Engineer. Any corrective action performed shall not reduce the integrity
4 or durability of the pavement that is to remain in place. Notify the Engineer 5 days prior
5 to commencement of the corrective action.

6 Localized roughness correction work shall be for the entire traffic lane width. Pavement
7 cross slope shall be maintained through corrective areas.

8 **710-8 PAVEMENT MARKING**

9 Mark the pavement at locations as shown on the plans with station numbers. Mark the
10 pavement by pressing beveled-face metal dies between 4" and 6" high into the plastic
11 concrete.

12 At locations where shoulder drain outlets are placed, mark the edge of pavement nearest the
13 outlet with the letters "OL". Use the same marking procedure as for station numbers.

14 **710-9 THICKNESS TOLERANCES**

15 A lot for thickness acceptance testing is defined in Article 710-4.

16 To establish an adjusted unit price, if appropriate, for mainline pavement, take one
17 4" diameter core from each lot at a random location as directed. Other areas such as
18 intersections, entrances, crossovers and ramps will each be considered as one lot and the
19 thickness of each of these lots will be determined separately. Small irregular areas may be
20 included as part of another lot. Take one core for each 1,333.3 sy of pavement or fraction
21 thereof in the lot.

22 When the measurement of any core, original core or additional cores taken to calculate the
23 average, is less than the plan thickness by more than 1.0", the extent of the removal area due
24 to thickness deficiency will be determined by taking additional exploratory cores at
25 approximately 10 ft intervals parallel to the center line in each direction from the deficient
26 core until an exploratory core is found in each direction which is within 1.0" of the plan
27 thickness. The pavement between these exploratory cores will be removed full lane width
28 wide and replaced with concrete of the thickness shown on the plans. Exploratory cores for
29 deficient thickness will not be used in averages for adjusted unit price.

30 When the measurement of the core from a lot is deficient by 0.2" or less from the plan
31 thickness, no pay reduction will be made for thickness. When such measurement is deficient
32 by more than 0.2" from the plan thickness, take 2 additional cores at random locations within
33 the lot and calculate the average thickness of the lot from the 3 cores.

34 In determining the average thickness of the pavement lot, the Engineer will use all 3 core
35 measurements. Individual core measurements which are greater than the plan thickness
36 + 0.2" will be considered as the plan thickness + 0.2". Individual cores which are less than
37 the plan thickness - 1.0" will be considered as the plan thickness - 1.0". If the average
38 measurement of the 3 cores is within 0.2" from the plan thickness, full payment will be made.
39 If the average measurement of the 3 cores is deficient by more than 0.2" from the plan
40 thickness, an adjusted unit price in accordance with Subarticle 710-10(B) will be paid for the
41 lot represented.

42 Areas found deficient in thickness by more than 1.0" shall be removed and replaced with
43 concrete of the thickness shown on the plans. Any full lane or full shoulder width repairs to
44 the concrete pavement shall be performed in accordance with the *North Carolina Department*
45 *of Transportation Partial and Full Depth Repair Manual* and not be less than 1/2 of the slab
46 length.

47 Patch all core holes within 72 hours of taking the core, using a Department approved
48 nonshrink grout compatible with the pavement concrete.

1 **710-10 MEASUREMENT AND PAYMENT**

2 **(A) General**

3 The quantity of Portland cement concrete pavement to be paid will be the actual number
4 of square yards of concrete pavement completed and accepted. In measuring this
5 quantity, the width of the pavement will be as called for on the plans or as directed. The
6 length will be the actual length constructed, measured along the centerline of the
7 pavement.

8 Separate measurement will be made of pavement that is deficient in thickness by more
9 than 0.2" and of pavement that is deficient in compressive strength.

10 The quantities of Portland cement concrete pavement will be paid at the contract unit
11 price per square yard for ___" *Portland Cement Concrete Pavement, Through Lanes, (with*
12 *dowels)*, ___" *Portland Cement Concrete Pavement, Ramps, (with dowels)* or ___" *Portland*
13 *Cement Concrete Pavement, Miscellaneous, (without dowels)*, or if applicable, at such
14 contract unit prices adjusted in accordance with the requirements shown below. No unit
15 price adjustments on lots will be made until a final determination of the lot strength and
16 depth is made. Pavement will be classified as through lane, ramp or miscellaneous
17 pavement in accordance with the classification shown on the plans.

18 Payment for all work of surface testing will be made at the contract lump sum price for
19 *Surface Testing Concrete Pavement*. Partial payments for surface testing will be
20 proportional to the percentage of pavement surface tested at the time the partial estimate
21 is prepared.

22 **(B) Pavement Deficient In Thickness**

23 The quantities of Portland cement concrete pavement which are deficient in thickness by
24 more than 0.2" but not deficient by more than 1.0", measured as provided in
25 Article 710-10, will be paid at an adjusted contract unit price per square yard for
26 ___" *Portland Cement Concrete Pavement, Through Lanes, (with dowels)*, ___" *Portland*
27 *Cement Concrete Pavement, Ramps, (with dowels)* or ___" *Portland Cement Concrete*
28 *Pavement, Miscellaneous, (without dowels)* completed in place and accepted.

29 The adjusted contract unit price is determined by the following formula, except no pay
30 over 100% will be allowed:

31
$$\text{Pay Factor (\%)} = 110 - \left[50 \times (\text{Plan Thickness} - \text{Average Core Thickness}) \right]$$

32 Exploratory cores for deficient thickness will not be used in averages for adjusted unit
33 price. Where pavement deficient by more than 1.0" is removed and replaced, the
34 replacement pavement will be paid at the contract unit price per square yard for
35 ___" *Portland Cement Concrete Pavement, Through Lanes, (with dowels)*, ___" *Portland*
36 *Cement Concrete Pavement, Ramps, (with dowels)* or ___" *Portland Cement Concrete*
37 *Pavement, Miscellaneous, (without dowels)* which price and payment will be full
38 compensation for all work of placement, removal, restoration of subgrade and base and
39 replacement.

Section 710

1 (C) Concrete Pavement Varying In Strength

2 One of the following formulas will be used to calculate the concrete pavement pay factor.

3 (1) Compressive Strength

4 The pay factor for pavement achieving a compressive strength in 28 days of
5 4,500 psi or greater is 100%. The pay factor for pavement achieving a compressive
6 strength in 28 days between 3,500 psi and 4,500 psi is determined by the following
7 formula:

$$8 \quad \text{Pay Factor (\%)} = 100.0 - \left[0.05 \times (4,500 - \text{Compressive Strength}) \right]$$

9 (pay factor rounded to nearest 0.1%)

10 (2) Flexural Strength

11 The pay factor for pavement achieving a flexural strength in 28 days of 650 psi or
12 greater is 100%. The pay factor for pavement achieving a flexural strength in
13 28 days between 600 psi and 650 psi is determined by the following formula:

$$14 \quad \text{Pay Factor (\%)} = 100.0 - (650 - \text{Flexural Strength})$$

15 (pay factor rounded to nearest 0.1%)

16 The quantities of Portland cement concrete pavement that meet these criteria, will be paid
17 at an adjusted unit price per square yard for ___" *Portland Cement Concrete Pavement,*
18 *Through Lanes, (with dowels),* ___" *Portland Cement Concrete Pavement, Ramps, (with*
19 *dowels)* or ___" *Portland Cement Concrete Pavement, Miscellaneous, (without dowels)*
20 completed in place and accepted. The adjusted contract unit price will be determined by
21 multiplying the contract unit price by the pay factor level determined for the average
22 strength of concrete in each lot and will be applicable to the total square yards of concrete
23 in each lot.

24 Any pavement that fails to attain 3,500 psi in compression is subject to removal. If
25 allowed to remain in place, the pavement will be accepted at a reduced unit price based
26 on a pay factor level of 50% as provided in Article 105-3.

27 Where pavement deficient in strength is removed and replaced, the replacement
28 pavement, if acceptable, will be paid at the contract unit price for ___" *Portland Cement*
29 *Concrete Pavement, Through Lanes, (with dowels),* ___" *Portland Cement Concrete*
30 *Pavement, Ramps, (with dowels)* or ___" *Portland Cement Concrete Pavement,*
31 *Miscellaneous, (without dowels)* which price and payment will be full compensation for
32 all work including placement, removal, restoration of subgrade and base and replacement.

33 (D) Multiple Adjustments in Price

34 Pavement found deficient in both thickness and strength will be evaluated by the
35 Engineer to determine if it may be permitted to remain in place. Pavement permitted to
36 remain in place will be paid at a reduced price determined by successively multiplying
37 the contract price by the appropriate factor indicated for each deficiency.

38 (E) Compensation

39 Payment at the contract unit prices for ___" *Portland Cement Concrete Pavement,*
40 *Through Lanes, (with dowels)* and ___" *Portland Cement Concrete Pavement Ramps,*
41 *(with dowels)* and ___" *Portland Cement Concrete Pavement, Miscellaneous, (without*
42 *dowels)* will be full compensation for all work covered by this section.

1 Payment at the contract lump sum price for *Surface Testing Concrete Pavement* will be
 2 full compensation for all work of surface testing including, but not limited to, furnishing,
 3 maintaining and operating the profilograph and towing equipment; for furnishing graph
 4 paper and any other materials and supplies for performing the surface testing; and for
 5 repairing membrane curing compound damaged during surface testing.

6 (F) Pay Items

7 Payment will be made under:

Pay Item	Pay Unit
___ " Portland Cement Concrete Pavement, Through Lanes (with dowels)	Square Yard
___ " Portland Cement Concrete Pavement, Ramps (with dowels)	Square Yard
___ " Portland Cement Concrete Pavement, Miscellaneous (without dowels)	Square Yard
Surface Testing Concrete Pavement	Lump Sum

8

SECTION 720

9

CONCRETE SHOULDERS

10 720-1 DESCRIPTION

11 Perform the work covered by this section including, but not limited to, the construction of
 12 Portland cement concrete shoulders in accordance with this section and with the lines, grades
 13 and dimensions shown on the plans; designing the mix; furnishing and placing the concrete
 14 shoulders; furnishing maturity testing equipment; furnishing all admixtures and additives;
 15 constructing joints; furnishing joint materials; curing the shoulder and furnishing curing
 16 materials; coring and patching core holes; taking actions to prevent or repair cracking; and
 17 removing and replacing unsatisfactory shoulder.

18 720-2 MATERIALS

19 Refer to Division 10.

Item	Section
Curing Agents	1026
Dowels and Tie Bars	1070-6
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000
Water	1024-4

20 720-3 COMPOSITION OF CONCRETE

21 Design the concrete mix in accordance with Section 1000.

22 720-4 ACCEPTANCE OF CONCRETE

23 The Engineer will test concrete shoulders for acceptance with respect to compressive strength
 24 and thickness on a lot by lot basis. A "lot" is defined in Article 710-4.

25 720-5 EQUIPMENT

26 Use equipment in the production and placement of the concrete shoulders in accordance with
 27 Section 700 and Section 1000.

28 720-6 CONSTRUCTION METHODS

29 Place the concrete shoulders only in the presence of an authorized representative of the
 30 Engineer. Construct concrete shoulders in accordance with Section 700.

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1 Place the full width of the shoulder in a single operation.

2 **720-7 FINISHING**

3 Finish the shoulder surface with approved equipment. Hand finishing will be permitted when
4 the use of mechanical finishing equipment is impractical.

5 Perform the final finishing of the shoulder surface by burlap dragging, brooming or other
6 acceptable methods that will produce a similar surface texture acceptable to the Engineer.

7 **720-8 JOINTS**

8 Construct and seal all joints in accordance with Articles 700-11 and 700-12 except as
9 provided in this article. Saw all joints in the concrete shoulder and seal with joint sealer as
10 shown in the plans.

11 Dowels will not be required at the transverse joints in the concrete shoulder. Use tie bars
12 between the concrete pavement and the concrete shoulder.

13 Match the transverse joints in the concrete shoulder with the transverse joints in the adjacent
14 concrete pavement.

15 **720-9 THICKNESS TOLERANCES**

16 The Engineer will determine the thickness of the shoulder by measurement of cores in
17 accordance with AASHTO T 148. A lot for thickness acceptance testing is defined in
18 Article 710-4.

19 Take one 4" core from each lot at a random location as directed. Core each location in the
20 presence of the Engineer. The Engineer will take immediate possession of the cores. Take
21 cores with a diameter of 4" and deliver them to the Engineer for measurement. When the
22 required thickness for the shoulder varies, each core will be measured and compared to the
23 required thickness for the shoulder at the location of the core. The deviation of the measured
24 core thickness from the required thickness will be recorded as a plus or minus value for each
25 core. Thickness tolerances in Article 710-9 apply for concrete shoulders.

26 **720-10 MEASUREMENT AND PAYMENT**

27 **(A) General**

28 *Concrete Shoulders Adjacent to ___" Pavement* will be measured and paid as the actual
29 number of square yards of shoulders completed and accepted. In measuring this quantity,
30 the width of the shoulders will be as called for on the plans or as directed by the
31 Engineer. The length will be the actual length constructed, measured along the surface of
32 the shoulders at the centerline of each shoulder.

33 **(B) Shoulder Deficient in Thickness**

34 Pay factors are determined in accordance with Subarticle 710-10(B). When the shoulder
35 is deficient in thickness by more than 1", the Engineer will determine if the shoulder can
36 be left in place or be removed and replaced. Where the Engineer determines the shoulder
37 can be left in place, the shoulder will be accepted at a reduced unit price not to
38 exceed 50% as provided in Article 105-3.

39 **(C) Concrete Shoulder Varying In Strength**

40 Concrete shoulders shall meet the strength requirements of Subarticle 710-10(C).

41 The quantities of concrete shoulder that fail to meet 4,500 psi, measured as provided in
42 Article 710-10, will be paid for at an adjusted unit price per square yard completed in
43 place and accepted. The adjusted contract unit price will be determined by multiplying
44 the contract unit price by the pay factor level in Subarticle 710-10(C).

1 Where concrete shoulder deficient in strength is removed and replaced, the replacement
 2 pavement, if acceptable, will be paid at the contract unit price for *Concrete Shoulders*
 3 *Adjacent to ___" Pavement*, which price and payment will be full compensation for all
 4 work of placement, removal and replacement.

5 **(D) Multiple Adjustments in Price**

6 Concrete shoulder found deficient in both thickness and strength will be evaluated by the
 7 Engineer to determine if it may be permitted to remain in place. Concrete shoulder
 8 permitted to remain in place will be paid at a reduced price determined by successively
 9 multiplying the contract price by the appropriate factor indicated for each deficiency.

10 **(E) Pay Items**

11 Payment will be made under:

Pay Item	Pay Unit
Concrete Shoulders Adjacent to ___" Pavement	Square Yard

12 **SECTION 725**
 13 **FIELD LABORATORY FOR**
 14 **PORTLAND CEMENT CONCRETE PAVEMENT**

15 **725-1 DESCRIPTION**

16 Perform the work covered by this section including, but not limited to, providing and
 17 maintaining the building or trailer and the curing shelter for the exclusive use of the Engineer
 18 at concrete plants producing Portland cement concrete for use in pavement to be constructed
 19 on the project; furnishing water, heat, electricity and other utility services; and any other
 20 equipment that may be necessary.

21 **725-2 GENERAL REQUIREMENTS**

22 Furnish and maintain for the exclusive use of the Engineer a field office and laboratory in
 23 which to house and use all testing equipment needed. Only Department representatives will
 24 have unattended access to these facilities.

25 Provide a field office that is dust and water tight, floored, and has an adequate foundation so
 26 as to prevent excessive floor movement. Provide a field office that contains 6 or more 110 V
 27 electrical double outlets properly grounded and spaced; a telephone; at least 2 windows,
 28 satisfactory locks on all doors and windows; adequate lighting, heating and air conditioning;
 29 sink; running water to sink; and satisfactory exhaust fan. Provide a field office that meets the
 30 following approximate minimum requirements: 200 sf of floor space; 9 ft interior width;
 31 6.5 ft interior height; 20 sf of counter space, 2.5 ft to 3 ft high and 2 ft deep with cabinets or
 32 drawers below the counter top; and 6 sf of desk space not enclosed with cabinets. Locate the
 33 office in a position that will permit full view of the plant from the interior of the office. At or
 34 near the office, furnish toilet facilities, with waste disposal, available for use of the
 35 Department personnel. Maintain these toilets in a neat and clean condition.

36 Provide a laboratory trailer adjacent to the field office that is at least 400 sf in area,
 37 approximately 20 ft wide, 20 ft long and 7 ft in height. Provide a laboratory trailer that
 38 contains 6 or more 110 V electrical double outlets properly grounded and spaced; satisfactory
 39 locks on all doors and windows; adequate lighting, heating and air conditioning; sink; running
 40 water to sink; and satisfactory exhaust fans. Provide two workbenches that are approximately
 41 10 ft long, 2 ft wide and 2.5 ft high. One workbench shall be installed inside the trailer and
 42 the other across the end of the trailer. Provide a shelter or roof over the outside workbench to
 43 provide protection from weather. Provide, in the laboratory, an adequate number of water
 44 storage tanks to hold all acceptance beams and cylinders and any additional beams and
 45 cylinders made for the purpose of determining early strengths.

Section 725

1 Construct the water storage tanks of non-corroding materials and have requirements for
2 automatic control of the water temperature. Maintain the water in the tank at a temperature of
3 $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$. Equip each tank with a recording thermometer with its bulb located in the water.
4 Provide sufficient tank volume to maintain all beams and cylinders, stored with the long axis
5 vertical, in a fully submerged condition for the duration of the required curing period. Furnish
6 a wooden mixing board at least 3/4" thick and approximately 4 ft wide and 4 ft long that is
7 covered on one side with sheet metal of at least 22 gauge, at the shelter. Provide facilities to
8 maintain the test beams and cylinders at temperature between 60°F and 80°F during initial
9 curing.

10 **725-3 MEASUREMENT AND PAYMENT**

11 *Field Laboratory Rental, Portland Cement Concrete Pavement* will be paid at the contract
12 lump sum price which will be made for furnishing and maintaining all field laboratories
13 available for use by the Engineer at any concrete plant producing Portland cement concrete
14 for use in pavement to be constructed on the project. Partial payments for field laboratory
15 rental will be made with the first and last partial pay estimates which include concrete
16 pavement or concrete shoulders. Payments will be made at the rate of 50% of the lump sum
17 price for *Field Laboratory Rental, Portland Cement Concrete Pavement* on each of these
18 partial pay estimates.

19 Payment will be made under:

Pay Item	Pay Unit
Field Laboratory Rental, Portland Cement Concrete Pavement	Lump Sum

DIVISION 8 INCIDENTALS

SECTION 800 MOBILIZATION

800-1 DESCRIPTION

This work consists of preparatory work and operations to mobilize personnel, materials and equipment to the project site.

800-2 MEASUREMENT AND PAYMENT

Mobilization will be paid as contract lump sum price.

Partial payments for *Mobilization* will be made with the first and second partial pay estimates paid on the contract and will be made at the rate of 50% lump sum price on each of these partial pay estimates, provided the amount bid for *Mobilization* does not exceed 5% of the total amount bid for the contract. Where the amount bid for *Mobilization* exceeds 5% of the total amount bid for the contract, 2.5% of the total amount bid will be paid on each of the first 2 partial pay estimates. That portion exceeding 5% will be paid on the last partial pay estimate.

As an exception to the above, where the work covered by the contract is limited exclusively to the resurfacing of an existing pavement, payment of the entire lump sum price for *Mobilization* will be made with the first partial pay estimate paid on the contract, provided the amount bid does not exceed 5% of the total amount bid for the contract. Where the amount bid for *Mobilization* exceeds 5% of the total amount bid for the contract, 5% of the total amount bid will be paid on the first partial pay estimate. That portion exceeding 5% will be paid on the last partial pay estimate.

Such price and payment includes, but is not limited to, the movement of personnel, equipment, supplies and incidentals to the project site, for the establishment of offices, buildings and other facilities necessary for work on the project; the removal and disbandment of those personnel, equipment, supplies, incidentals or other facilities that were established for the prosecution of work on the project; and for all other work and operations that shall be performed for costs incurred before beginning work on the various items on the project site.

Payment will be made under:

Pay Item	Pay Unit
Mobilization	Lump Sum

SECTION 801 CONSTRUCTION STAKES, LINES AND GRADE

801-1 DESCRIPTION

When required by the contract, provide all construction layout, surveying, stakeout, supplemental surveying and engineering necessary for the proper control of construction operations in accordance with this section and the *Manual for Construction Layout*. Provide a stakeout of areas where an environmental permit is required before performing any construction in or adjacent to these areas. Stake out limits of the permitted work areas according to the approved permit drawings. Provide clear delineation by use of highly visible flagging. Insure construction limits do not exceed approved permitted work areas. Immediately notify the Engineer of any variations of the stakeout limits when compared to the approved permit drawings.

Section 801

1 The *Manual for Construction Layout* and the *Guidelines for Drainage Studies and Hydraulic*
2 *Design* may be obtained from the Contract Standards and Development Unit.

3 **801-2 CONSTRUCTION METHODS**

4 **(A) General**

5 Furnish personnel who are under the direct supervision of an engineer or land surveyor
6 licensed by the State of North Carolina in conformance with NCGS § 89C.

7 Furnish personnel who are experienced in highway construction surveying and are
8 capable of accurately establishing all line and grade points necessary to complete the
9 work in accordance with the plan dimensions within the precision established in the
10 *Manual for Construction Layout*. Consult the Engineer for clarifications of the plans.

11 Perform work in safe manner and conform to Article 107-21. Perform all flagging
12 operations in accordance with Section 1150.

13 The Contractor may elect to use global positioning system (GPS) surveying, either static
14 or kinematic. Perform GPS surveys with same or higher order of accuracy as
15 conventional surveys detailed in the *Manual for Construction Layout*. Department
16 projects use a localized coordinate system developed by the Location and Surveys Unit
17 specifically for each individual project. Obtain the control information that the Location
18 and Surveys Unit used in establishing the localized coordinate system, specifically the
19 rotation, scaling, translation and coordinates for the azimuth pairs. Newly developed
20 GPS procedures and techniques that do not conform with this section may be used, if
21 approved.

22 Investigate the plan horizontal alignment, vertical profile and superelevation of existing
23 facilities that tie to proposed roadways. Investigate 100 ft beyond all paving limits and
24 revise grades as needed to establish smooth transitions to the existing facilities.

25 Tie existing driveways to proposed facilities within the limits detailed in the plans and
26 within the gradients detailed in the *Roadway Standard Drawings*.

27 The Engineer reserves the right to check, correct where necessary or require any layout
28 work to be revised. The Engineer will perform checks to ensure the roadway, structure
29 and incidental items are surveyed in accordance with the plans and the *Manual for*
30 *Construction Layout*.

31 The Department's review of the Contractor's work in no way relieves the Contractor of
32 responsibility for conformance with the contract. Failure by the Engineer or inspector to
33 point out unsatisfactory work, from lack of discovery or for any other reason, in no way
34 prevents later rejection or corrections to the unsatisfactory work, when discovered. No
35 claims will be allowed for losses suffered due to any necessary removals or repairs
36 resulting from the unsatisfactory work.

37 When requested by the Engineer, check the accuracy of the stakeout. Correct all
38 inaccuracies in the construction stakeout before performing the affected work.

39 When the Contractor proposes an alteration to the plans to rectify a construction stakeout
40 error, submit alterations to the Engineer for review and approval. Include design
41 calculations and drawings sealed by an engineer licensed by the State of North Carolina
42 along with a narrative describing justification for the alteration.

1 When surveying is required, which in the Contractor's opinion could not have been
 2 reasonably anticipated and is not customary or inherent to the construction industry,
 3 notify the Engineer in writing before beginning such surveying. After investigation, the
 4 following will occur:

5 (1) When the Engineer determines that the surveying could not have been anticipated or
 6 is not customary or inherent to the construction industry, the Contractor will be
 7 notified in writing that the work is considered supplemental and measurement and
 8 payment will be made in accordance with Article 801-3.

9 (2) When the Engineer determines that the surveying could have been anticipated or is
 10 customary or inherent to the construction industry, he will notify the Contractor, in
 11 writing, of his determination. If the Contractor intends to file a claim for additional
 12 compensation by reason of such surveying, notify the Engineer in writing of such
 13 intent before beginning any of the alleged supplemental surveying. Strictly adhere to
 14 Subarticle 104-8(B).

15 **(B) Records**

16 Submit proposed method for setting up survey books or electronic data files to the
 17 Engineer before beginning work to assure clarity and adequacy.

18 Promptly make available to the Engineer all requested survey records.

19 Provide updates to the Engineer monthly of the electronic and/or manuscript survey
 20 records. Submit remaining records upon completion of the work. Attest the work was
 21 performed in accordance with the contract by providing all receivable information signed
 22 by an engineer or land surveyor licensed by the State of North Carolina and in
 23 responsible charge.

24 **(C) Horizontal and Vertical Control**

25 The Department will furnish and set horizontal baseline control on approximate 1,000 ft
 26 intervals and vertical control on approximate 2,500 ft intervals within the project limits.
 27 Obtain a copy of the electronic survey control files from the Engineer.

28 Clearing limits may be established during original traverse of baseline control provided
 29 the accuracy ratio does not exceed 1 ft per 5,000 ft of perimeter and all Department
 30 established baseline control is protected and preserved during clearing operations. Before
 31 performing any additional construction layout, verify the horizontal baseline control by
 32 a closed traverse survey or alternate approved method. The accuracy ratio shall not
 33 exceed an error of closure of 1 ft per 20,000 ft of perimeter. Verify the vertical control
 34 by performing a closed loop survey using differential leveling. For the error of closure,
 35 do not exceed 0.05 ft times the square root of the miles:

$$36 \quad \text{Error of Closure} \leq 0.05 \text{ ft} \sqrt{(x) \text{ miles}} .$$

37 Notify the Engineer of any discrepancies in either the horizontal or vertical control.
 38 Reference, outside of the proposed construction limits and evenly distributed throughout
 39 the project limits, a minimum of 50% of the Department's horizontal and vertical control.
 40 Provide reference information to the Engineer.

41 If GPS is used, occupy the azimuth pairs with the base station during verification of
 42 baseline control, otherwise, occupy baseline. Verify remaining baseline control using a
 43 Rover. Submit coordinate data showing differences between supplied baseline
 44 coordinates and field obtained GPS coordinates. Include report detailing the use of
 45 preliminary input data, specifically rotation, scaling and translation.

Section 801

1 Using the horizontal and vertical control established by the Department, provide
2 surveying necessary to construct all roadway, structure and miscellaneous items as
3 detailed in the plans. Perform staking in accordance with the *Manual for Construction*
4 *Layout*. Layout the work and provide all measurements that may be required for the
5 execution of the construction in conformity with the contract.

6 **(D) Right of Way, Control of Access and Easements**

7 The Department will establish the location of all proposed right-of-way markers, control-
8 of-access markers and permanent drainage easements.

9 Reference the location of all proposed markers and permanent drainage easements.
10 Restore right-of-way and control-of-access monument positions after completion of
11 construction. Set a right-of-way or control-of-access monument cap on an 18" long
12 #5 reinforcing bar and a carsonite witness stake unless concrete right-of-way and control-
13 of-access markers are specified in the contract. The Department will provide the
14 monument cap and witness stake. Re-establish location of permanent drainage easements
15 after completion of construction and install an 18" long #5 reinforcing bar for
16 monumentation.

17 Validate the position of the markers and permanent drainage easement locations with
18 those detailed in the plans. Report any discrepancies to the Engineer.

19 **(E) Cross sections for Earthwork Quantities**

20 The Engineer may elect to obtain cross sections either by hand or aerial methods. If the
21 Engineer elects to obtain cross sections by aerial methods, furnish materials and install
22 photogrammetric control panels in accordance with the *Manual for Construction Layout*
23 or as otherwise directed.

24 (1) Borrow Pits

25 Establish a baseline alignment or establish horizontal and vertical control on
26 approximate 1,000 ft intervals within each borrow pit, as necessary, to allow the
27 Engineer to obtain measurement of quantities for payment. Stake these alignments
28 just before field cross sections are taken by the Engineer for original, intermediate
29 and final cross sections.

30 (2) Roadway

31 Unless otherwise directed, stakeout the survey lines for original and final cross
32 sections. The stakeout of the survey lines will consist of surveying and staking all
33 alignments within the plans on 50 ft intervals, including all cardinal points. When
34 the alignments are inaccessible, install offset alignments. Begin the staking of these
35 alignments within 48 hours of the Engineer's notice to proceed. Upon the
36 completion of the entire project, with the exception of the survey line for final cross
37 sections, and upon request by the Contractor, the project may be accepted for
38 maintenance by the Department, excluding the survey line.

39 **(F) Drainage and Utility Construction Systems**

40 (1) General

41 Where underground conflicts are suspected, contact utility owners and locate all
42 utilities horizontally and vertically. Consider the utilities' locations and elevations in
43 the layout of the drainage systems and utility construction systems. Utilities may
44 exist that are not depicted in the plans.

1 Submit 2 copies of all layout drawings for drainage systems and utility construction
2 systems to the Engineer for his review and approval. The Engineer will note the
3 review and approval by adding an appropriate note to the drawings along with the
4 date and his signature. The Engineer will retain a copy of the drawings and a copy
5 will be returned to the Contractor.

6 (2) Drainage Systems

7 Provide construction layout of drainage systems, as depicted in the plans and in
8 accordance with the *Guidelines for Drainage Studies and Hydraulic Design*.
9 Consider the locations and elevations of all existing and proposed utilities, proposed
10 utility construction and existing and proposed drainage systems, in the layout of the
11 drainage system. Modifications of the drainage plan may be necessary to properly
12 collect and transport water. Advise the Engineer if modifications are needed to
13 achieve the original design functionality and the intent of the drainage plans, such as
14 adjusting the location of a drainage structure, adding a drainage structure and
15 increasing or decreasing pipe lengths. The Engineer will review any major
16 modifications.

17 Provide layout drawing of the drainage system including calculations of flow line
18 elevations for all drainage structures; pipe invert elevations, both inlet and outlet of
19 the drainage structure; grade of each pipe within the drainage system; elevation of
20 any existing facility connection, such as stream or pipe; if necessary; headwall
21 location, if depicted in the plans; and locations and elevations of any existing or
22 proposed utilities to the Engineer for review and approval at least 7 days before
23 beginning work on the drainage system. Modification of the submitted drainage
24 layout drawing by the Engineer will not eliminate the Contractor's liability for the
25 accuracy of the information submitted. Any restaking or additional staking required
26 to conform with the approved drainage layout drawing is incidental to the work.

27 (3) Utility Construction

28 Provide utility construction layout as detailed in the contract. Consider the locations
29 and elevations of all existing and proposed utilities, proposed utility construction and
30 existing and proposed drainage systems in the layout of the utility construction.
31 Advise the Engineer if modifications to the utility construction plans are necessary.
32 The Engineer will review any major modifications.

33 Provide layout drawing of the utility construction system including elevations of any
34 existing utilities, drainage systems and/or proposed drainage systems to the Engineer
35 for review and approval at least 7 days before beginning work on the utility
36 construction system. Modification of the submitted utility construction layout
37 drawing by the Engineer will not eliminate the Contractor's liability for the accuracy
38 of the information submitted. Any restaking or additional staking required to
39 conform with the approved utility layout drawing is incidental to the work.

40 (G) Structures

41 Provide surveying and calculations necessary to construct structures in accordance with
42 the plans. Provide staking in accordance with the *Manual for Construction Layout*.
43 Establish horizontal alignment of entire structure. Set at least one benchmark adjacent to
44 the structure site that will be retained throughout the structure construction. The
45 Engineer will furnish the finished construction elevations for use in determining the
46 required construction elevations for bridges. Provide method for computing buildups
47 over beams, screed grades and overhang form elevations to the Engineer for review
48 before staking these items to assure clarity and adequacy.

Section 801

1 Submit 2 copies of structure layout drawings to the Engineer for his review and approval.
2 The Engineer will independently verify and accept the structure layout before the
3 structure construction may begin. The Engineer will note the review and approval by
4 adding an appropriate note to the drawings along with the date and his signature. The
5 Engineer will retain a copy of the drawings and a copy will be returned to the Contractor.

6 If structure phasing or damaged stakes require significant resurveying during the life of
7 the structure, provide revised layout drawing for the Engineer's verification and
8 acceptance.

9 (H) Signs

10 Stake horizontal locations of all overhead and Type A and B ground-mounted signs for
11 Engineer's verification before obtaining S-dimensions. Measure or calculate overhead
12 and ground-mounted sign S-dimensions in accordance with the plans and the *Manual for*
13 *Construction Layout*. Perform investigation of proposed sign locations and notify the
14 Engineer of any obstructions, either existing or proposed, that may interfere with the
15 proposed sign installation. Provide an 11" x 17" drawing depicting the theoretical
16 finished section at each proposed overhead sign assembly location. Include within the
17 submittal the roadway, shoulder and slope gradients. Include the proposed finish
18 elevations of the edges of pavement, each lane line and the ground at each proposed sign
19 footing location. Set a slope stake at each proposed overhead sign location to ensure the
20 slopes are constructed as calculated and detailed in the above submittal. Submit sign
21 information to the Engineer. Stake horizontal locations of all ground mounted and barrier
22 mounted signs.

23 801-3 MEASUREMENT AND PAYMENT

24 *Construction Surveying* will be paid at the contract lump sum price for the work detailed in
25 this section.

26 Partial payments will be made on each particular payment estimate based upon the percentage
27 complete of *Construction Surveying* as determined by the Engineer. The Contractor shall
28 submit a certified statement each month indicating the percentage of *Construction Surveying*
29 work completed. The Engineer will determine if the amount indicated is reasonably correct
30 and the Engineer will pay accordingly on the next partial pay estimate.

31 Establishment of baseline alignments within each borrow pit is incidental to *Construction*
32 *Surveying*.

33 *Supplemental Field Surveying* will be measured and paid as the actual number of hours the
34 Contractor's survey crew is actively engaged in performing the following:

35 (A) Investigative surveying, in excess of 100 ft of horizontal alignment, vertical profile and
36 superelevation of existing facilities that tie to proposed roadways.

37 (B) Surveying specifically for the relocation of utility conflicts.

38 (C) Investigation of a previous stakeout when such stakeout is found to be correct.

39 (D) Surveying that the Engineer has deemed could not have been anticipated or is not
40 customary or inherent to the construction industry.

41 (E) The stakeout of the roadway survey alignments for intermediate cross sections when
42 deemed necessary by the Engineer.

43 If the Engineer determines intermediate cross sections are not necessary for computing partial
44 payments, the intermediate stakeout of the survey line is incidental to the work.

45 *Supplemental Surveying Office Calculations* will be measured and paid as the actual number
46 of hours the Contractor's survey personnel is actively engaged in performing office
47 calculations specifically associated with Subarticles 801-3(A) through 801-3(E).

1 *Supplemental Surveying Office Calculations* will be paid at the stated price of \$60.00 per
 2 hour. *Supplemental Field Surveying* will be paid at the stated price of \$110.00 per hour. The
 3 payment includes furnishing personnel, all surveying equipment, stakes, layout drawings,
 4 calculations, stakeout records and any materials and equipment necessary to perform the
 5 surveying and engineering work.

6 If the Engineer directs that the accuracy of the original stakeout be checked and the stakeout
 7 is found to be in error, perform the work required to check and correct the stakeout at no cost
 8 to the Department.

9 *Exploratory Excavation* required to locate a utility will be paid in accordance with
 10 Article 104-7.

11 *Work Zone Signs (Portable)* will be paid in accordance with Article 1110-4.

12 *Flaggers* will be paid by either the hour or day in accordance with Article 1150-4.

13 Any payments for *Supplemental Field Surveying* or *Supplemental Surveying Office*
 14 *Calculations* required by this section will be paid on the appropriate partial payment estimate.

15 Payment will be made under:

Pay Item	Pay Unit
Construction Surveying	Lump Sum
Supplemental Field Surveying	Hour
Supplemental Surveying Office Calculations	Hour

16

SECTION 802

17

DISPOSAL OF WASTE AND DEBRIS

18

802-1 DESCRIPTION

19 The work consists of the disposal of waste and debris including, but not limited to, furnishing
 20 any waste areas; providing and implementing a Development, Use and Reclamation Plan; any
 21 right of access to waste areas; disposing of waste and debris; dressing and shaping of waste
 22 areas; furnishing and spreading earth material over debris, rock, broken pavement and
 23 masonry; clearing and grubbing of waste areas; hauling waste and debris to waste areas or
 24 permitted landfills; assessment for wetlands and endangered species; obtaining required
 25 permits or certifications; and any tipping fees required for disposal in permitted landfills.

26 Define “waste” as all excavated materials that are not used in the construction of the project,
 27 including overburden from borrow sources and soil-type base course sources.

28 Define “debris” as all undesirable material encountered on the project.

29

802-2 GENERAL REQUIREMENTS

30 Follow the most recent reclamation procedures found on the Department’s website for all
 31 waste sites. Before the removal of any waste from any project, obtain certification from the
 32 State Historic Preservation Officer of the State Department of Cultural Resources certifying
 33 that the deposition of the waste material to the proposed waste area will have no effect on any
 34 known district, site building, structure or object, architectural or archaeological, that is
 35 included, or eligible for inclusion, in the National Register of Historic Places. Furnish a copy
 36 of this certification to the Engineer before performing any work in the proposed waste site.

37 Provide an area and dispose of waste and debris outside of the right of way, unless otherwise
 38 allowed by written request. Limit the materials placed in non-permitted disposal areas to
 39 clean soil, rock, concrete, brick, other inert materials and bituminous asphalt when placed at
 40 least 4 ft above the water table. Mixtures of soil and vegetation, that are primarily soil, may
 41 be placed in non-permitted disposal areas. Place all other debris in sites permitted by the
 42 Solid Waste Management Division of NCDENR, unless otherwise approved.

Section 802

1 Maintain the earth surfaces at all waste areas in a manner that will effectively control erosion
2 and siltation until final acceptance of the project.

3 Shape the waste or disposal area to drain such that no water will collect or stand. Provide
4 a functioning drainage system.

5 Shape rock and earth waste to contour and blend with the adjacent topography. Cover all
6 rock, concrete, broken pavement and masonry with a minimum 6" thick layer of earth
7 material from the project or borrow. Earth material should be tested to insure it will support
8 long-term growth of the proposed ground cover and should be amended as necessary to
9 support permanent growth. As an exception, side slopes constructed of all rock material will
10 not require earth covering. Construct all slopes, other than rock, 2:1 or flatter. Construct rock
11 slopes on a stable angle of repose.

12 Where the Engineer has granted permission to dispose of waste within the right of way, the
13 Engineer will have the authority to establish whatever additional requirements may be
14 necessary to insure the satisfactory appearance and drainage of the completed project.

15 Where electing to dispose of waste or debris in active public waste or disposal sites, provide
16 evidence satisfactory to the Engineer that the Solid Waste Management Division of NCDENR
17 has permitted the proposed area or site.

18 Where electing to dispose of waste in a waste or disposal area, other than active public waste
19 or disposal areas permitted by the Solid Waste Management Division of NCDENR or on the
20 Department's right of way or an existing borrow pit, submit jointly with the property owner
21 a notarized Development, Use and Reclamation Plan for each waste or disposal area proposed
22 for use.

23 As part of the Reclamation Plan, perform the following before wasting:

24 (A) Material Description

25 Detail the type of waste material proposed in the area. Only material originating from the
26 Department's projects and complying with the Solid Waste Disposal Act will be
27 permitted within the proposed waste or disposal area.

28 (B) Topography

29 Detail the existing topography and locations of the proposed access and egress haul
30 roads. Detail the proposed final topography of the waste or disposal area showing any
31 proposed drainage systems. If a pond is to be constructed or remain, the minimum depth
32 shall be at least 4 ft as determined from the water table at the time the reclamation plan is
33 executed. The slope of the soil below the water shall be between 5:1 and 2:1. The slope
34 of the sides above the water line shall be 2:1 or flatter.

35 (C) Slopes

36 Rock and earth waste shall be shaped to contours that are compatible to and blend with
37 the adjacent topography. Cover all rock with a minimum 6" layer of earth material either
38 from project waste or from borrow. As an exception, side slopes constructed of all rock
39 material will not require earth covering. Construct all slopes at a 2:1 or flatter except
40 rock slopes that shall be on a stable angle of repose.

41 (D) Construction Debris

42 Cover construction debris and all broken pavement and masonry with a minimum
43 6" thick layer of earth waste material from the project or borrow. Shape the completed
44 waste area as required above for the disposal of earth or rock waste.

(E) Erosion Control

Detail the temporary and permanent erosion control measures, along with design calculations, that are intended during use of the site and as part of the reclamation. Unless considered impractical due to special circumstances, provide in the plan for the use of staged permanent seeding and mulching and appropriate fertilizer topdressing on a continual basis during site use and the immediate total reclamation of the site when the site is no longer needed. Define the seed mixture proposed for establishing temporary and/or permanent vegetation. Establish permanent stand of vegetation before acceptance of project.

(F) Evaluation for Potential Wetlands and Endangered Species

Hire an experienced environmental consultant on the Department's approved list to perform an assessment of the waste site for potential conflicts with wetlands, areas of environmental concern, federally listed threatened or endangered species, and federal species of concern.

Delineate the boundaries of any wetlands or jurisdictional surface waters (streams) encountered. Follow the standard practice for documenting the wetland delineation including completion of the US Army Corps of Engineer's approved Wetland Determination Data Form. Document information including data regarding soil, vegetation and hydrology. Maintain a minimum 25 ft buffer adjacent to all sides of the wetland boundary and a minimum 50 ft buffer adjacent to any stream. Depict the limits of the delineated wetland and surrounding buffer on the Reclamation Plan. Do not dispose of waste and debris in any area under the Corps of Engineers' or any other environmental agencies' regulatory jurisdiction unless and until the NCDOT permit has been modified to permit such disposal activity in the jurisdictional area.

Perform a site assessment for federally listed threatened or endangered species to include habitats that may support these species. Provide to the Engineer a detailed report on the assessment findings. If federally listed threatened or endangered species, or habitat that may support such species, exist on the proposed waste site, notify the Engineer before continued pursuit of such site.

(G) Buffer Zones

Allocate sufficient area between the nearest property line and the tie-in of the slope to natural ground to allow for the operation of excavation, hauling, and seeding equipment and for the installation of any and all erosion control devices required. Leave additional undisturbed area between the source and any watercourse or body to prevent siltation of the watercourse or body and the movement of the shore line either into the watercourse or body or into the waste areas. Determine if the adjoining property owners or other government agencies require any additional buffer zones and comply with those requirements. [Suggested minimum distances are 10 ft from property lines and 50 ft from water bodies or watercourses.] Do not place waste material within the 100-year floodplain unless superseded by an environmental permit.

(H) Approval

Obtain written approval from the Engineer before wasting within the proposed waste or disposal area.

Submit a revised or additional reclamation plan if the non-permitted waste or disposal area is expanded by more than one acre or is significantly changed from the previously approved submittal.

Section 806

1 **802-3 MEASUREMENT AND PAYMENT**

2 Seeding and mulching, fertilizer topdressing and establishing erosion control measures for
3 waste or disposal areas will be measured and paid at the contract unit prices for the items
4 established in the contract.

5 When permitted to waste within the right of way and when the waste area requires additional
6 covering material before seeding, provide covering material at no cost to the Department.

7 When waste areas are located outside the right of way, no payment will be made for any
8 borrow used to cover rock, broken pavement, masonry or other inert materials.

9 Except as otherwise provided above, no direct payment will be made for the work covered by
10 this section. Payment at the contract prices for the various items in the contract will be full
11 compensation for all work covered by this section.

12 **SECTION 806**
13 **RIGHT-OF-WAY AND CONTROL-OF-ACCESS MARKERS**

14 **806-1 DESCRIPTION**

15 Furnish and install precast concrete or granite markers to mark the boundaries of the right of
16 way or the control of access in accordance with the contract.

17 **806-2 MATERIALS**

18 Refer to Division 10.

Item	Section
Deformed Steel Bar Reinforcement	1070-2
Precast Concrete Units	1077

19 The Contractor may, at his option, use either granite or concrete markers. Make granite
20 markers from granite that is hard and durable, of a light color, free from seams which impair
21 its structural integrity, and of a good, smooth splitting appearance.

22 **806-3 CONSTRUCTION METHODS**

23 Precast the right-of-way and control-of-access markers in watertight forms of a size and shape
24 that will produce a completed marker of the dimensions shown in the *Roadway Standard*
25 *Drawings*. Construct the forms so as to impress the plastic concrete with the lettering and
26 markings shown in the contract.

27 Cure the concrete in accordance with Article 420-15. Give that portion of the marker that will
28 be above the surface of the ground ordinary surface finish in accordance with
29 Subarticle 420-17(B).

30 If using granite markers, quarry and finish the markers to the dimensions indicated in the
31 contract. Drill holes will be permitted in the sides and bottom.

32 Install the markers vertically in the ground to the depth and locations specified in the contract.
33 Thoroughly tamp backfill material.

34 **806-4 MEASUREMENT AND PAYMENT**

35 *Right-of-Way Markers* will be measured and paid in units of each for the actual number of
36 right-of-way markers furnished, installed and accepted.

37 *Control-of-Access Markers* will be measured and paid in units of each for the actual number
38 of control-of-access markers furnished, installed and accepted.

1 Payment will be made under:

Pay Item	Pay Unit
Right-of-Way Markers	Each
Control-of-Access Markers	Each

2

SECTION 808

3

OBLITERATION OF EXISTING ROAD

4

808-1 DESCRIPTION

5

The work covered by this section consists of the obliteration of an existing road outside of the construction limits.

6

7

808-2 CONSTRUCTION METHODS

8

Remove any existing pavement as directed. Fill or grade and shape the entire roadway to a degree that will blend with the adjacent topography and suitable for the application of vegetative cover.

9

10

11

808-3 MEASUREMENT AND PAYMENT

12

Removal of Existing Asphalt Pavement and *Removal of Existing Concrete Pavement* will be measured and paid in accordance with Article 250-3. The work includes, but is not limited to, all breaking up, removing, and disposing of pavement; all plowing of the roadbed; and all grading and excavation necessary to reshape the roadway.

13

14

15

16

Removal of Existing Concrete Pavement will be measured and paid in accordance with the requirements of Article 250-3. Such price includes, but is not limited to, all breaking up, removing and disposing of pavement; all plowing of the roadbed; and all grading and excavation necessary to reshape the roadway.

17

18

19

20

All materials excavated in obliterating the abandoned roadway will be paid at the contract price for *Unclassified Excavation* in accordance with Article 225-7.

21

22

Any additional material that is required to complete the reshaping of the roadway will be paid at the contract unit price for *Unclassified Excavation* in accordance with Article 225-7 or at the contract unit price for *Borrow Excavation* in accordance with Article 230-5, depending on the source of the material.

23

24

25

26

All seeding and mulching performed on obliterated areas will be paid at the contract unit prices for the items established in the contract.

27

28

SECTION 815

29

SUBSURFACE DRAINAGE

30

815-1 DESCRIPTION

31

Construct subsurface drains, underdrains, blind drains and other types of drains in accordance with the contract or as directed. Install markers to locate concrete pads for drains as shown in the plans. This section does not apply to shoulder drains; see Section 816.

32

33

34

815-2 MATERIALS

35

Refer to Division 10.

Item	Section
Geotextile for Subsurface Drains, Type 1	1056
Pavement Marker Paint	1087
Portland Cement Concrete, Class B	1000
Select Material, Class V	1016
Steel Marker Paint	1080-12
Steel Markers	1072-2

Section 815

Item

Subsurface Drainage Materials

Section

1044

- 1 Use Class B concrete for concrete pads. Provide Type 1 geotextile for filtration geotextiles.
2 Provide subdrain coarse aggregate (standard size No. 78M) for subsurface drains and subdrain
3 fine aggregate (standard size No. 2S or 2MS) for underdrains and blind drains.

4 **815-3 CONSTRUCTION METHODS**

- 5 Excavate trenches as necessary in accordance with the contract or as directed. Install blind
6 drains at a depth of 4 to 6 ft below subgrade elevation. Install subdrain pipes for subsurface
7 drains and underdrains at a depth of 4 to 6 ft below subgrade elevation unless the subgrade
8 will be proof rolled. For subsurface drains and underdrains in subgrades that will be proof
9 rolled, install subdrain pipes at a depth of 6 ft below subgrade elevation.

- 10 Do not leave filtration geotextiles exposed for more than 7 days before covering with
11 material. For subsurface drains, line trench with filtration geotextiles and overlap adjacent
12 geotextiles at least 18". Overlap geotextile closures on top of subdrain coarse aggregate at
13 least 6" and secure with mechanical ties.

- 14 Provide subdrain pipes with positive drainage towards outlets. Firmly connect subdrain pipes
15 together as needed. Place perforated subdrain pipes with perforations down except for pipes
16 in dry materials, in which case turn perforations up or use non-perforated pipes. For concrete
17 pipes in dry materials, construct joints that meet Subarticle 300-6(A).

- 18 Place subdrain aggregate beneath, around and over subdrain pipes such that pipes are covered
19 by at least 6" of aggregate unless shown otherwise in the plans. Do not displace or damage
20 subdrain pipes while placing and compacting subdrain aggregate. Lightly compact backfill
21 material such that settlement is minimized.

- 22 Use solvent cement for connecting Schedule 40 PVC outlet pipes and fittings such as wyes,
23 tees and elbows. Provide connectors for outlet pipes and fittings that are watertight and
24 suitable for gravity flow conditions. Cover open ends of outlet pipes with rodent screens as
25 shown in the plans.

- 26 Connect drains to concrete pads or existing drainage structures at ends of outlet pipes.
27 Construct concrete pads and provide an ordinary surface finish in accordance with Section
28 825. Install steel and pavement markers at concrete pads as shown in the plans.

- 29 Allow drains to function for up to 30 days or a sufficient time as determined by the Engineer
30 before undercutting, proof rolling or constructing embankments over drains.

31 **815-4 MEASUREMENT AND PAYMENT**

- 32 *Subdrain Excavation* will be measured and paid in cubic yards. Excavation will be measured
33 based on the trench width shown in the plans or approved by the Engineer and the actual
34 trench depth as determined by the Engineer. The contract unit price for *Subdrain Excavation*
35 will be full compensation for excavating trenches and backfilling above subdrain aggregate.

- 36 *Geotextile for Subsurface Drains* will be measured and paid in square yards. Filtration
37 geotextiles in a trench will be measured in place based on the subdrain aggregate width shown
38 in the plans or approved by the Engineer and the actual aggregate depth as determined by the
39 Engineer. No additional payment will be made for overlapping geotextiles. The contract unit
40 price for *Geotextile for Subsurface Drains* will be full compensation for supplying,
41 transporting and installing filtration geotextiles and mechanical ties.

Section 816

1 *Subdrain Fine Aggregate* and *Subdrain Coarse Aggregate* will be measured and paid in cubic
2 yards. Subdrain aggregate in a trench will be measured in place based on the aggregate width
3 shown in the plans or approved by the Engineer and the actual aggregate depth as determined
4 by the Engineer. When subdrain aggregate is not placed in a trench, aggregate will be
5 measured in place based on the aggregate dimensions shown in the plans or as determined by
6 the Engineer. The contract unit prices for *Subdrain Fine Aggregate* and *Subdrain Coarse*
7 *Aggregate* will be full compensation for furnishing, hauling, handling, placing, compacting
8 and maintaining subdrain aggregate.

9 ___" *Perforated Subdrain Pipe* and ___" *Outlet Pipe* will be measured and paid in linear feet.
10 Pipes will be measured in place as the pipe length, including fittings, to the nearest 0.1 ft with
11 no deduction for fittings. The contract unit prices for ___" *Perforated Subdrain Pipe* and
12 ___" *Outlet Pipe* will be full compensation for supplying, transporting and installing pipes,
13 fittings and rodent screens and making joint connections.

14 *Subdrain Pipe Outlets* will be measured and paid in units of each. Outlets will be measured
15 as the number of concrete pads or connections to existing drainage structures. The contract
16 unit price for *Subdrain Pipe Outlets* will be full compensation for concrete pads including
17 furnishing concrete, constructing pads and providing and placing markers and connecting
18 pipes to existing drainage structures including cutting into structures, removing existing paved
19 ditches and grouting around connections.

20 Payment will be made under:

Pay Item	Pay Unit
Subdrain Excavation	Cubic Yard
Geotextile for Subsurface Drains	Square Yard
Subdrain Fine Aggregate	Cubic Yard
Subdrain Coarse Aggregate	Cubic Yard
___" Perforated Subdrain Pipe	Linear Foot
___" Outlet Pipe	Linear Foot
Subdrain Pipe Outlet	Each

21

SECTION 816 SHOULDER DRAINS

22

816-1 DESCRIPTION

24 Construct shoulder drains and furnish and install painted pavement markers and vertical
25 markers to locate concrete pads for the drains in accordance with the requirements of the
26 contract.

816-2 MATERIALS

28 Refer to Division 10.

Item	Section
Concrete Pipe and Fittings	1044-3
Corrugated Plastic Pipe and Fittings	1044-7
Corrugated Steel Pipe and Fittings	1044-5
Geotextile for Shoulder Drains, Type 1	1056
Outlet Pipe	1044-8
Pavement Marker Paint	1087
PVC Pipe	1044-6
Portland Cement Concrete, Class B	1000
Shoulder Drain Aggregate, No. 57 Stone	1005
Steel Marker	1072-2
Steel Marker Paint	1080-12

Section 816

1 Use Class B concrete for concrete pads. Provide Type 1 geotextile for filtration geotextiles.
2 Material for shoulder drain pipe and fittings may be concrete, corrugated steel or corrugated
3 plastic.

4 **816-3 CONSTRUCTION METHODS**

5 Excavate the trench to the width, depth, lines and grades shown in the plans unless otherwise
6 directed.

7 Do not leave filtration geotextiles exposed for more than 7 days before covering with
8 material. Overlap adjacent filtration geotextiles at least 18". Overlap geotextile closures at
9 the top of the trench at least 6" and secure with mechanical ties. Where outlet pipes pass
10 through geotextiles, wrap a separate piece of geotextile around the outlet pipe, flare against
11 the side of the filled drain and secure with anchor pins.

12 Anchor field splices of geotextile with anchor pins to ensure that required overlap is
13 maintained.

14 Perform aggregate placement operations and the pipe installation to prevent damage to
15 filtration geotextiles. Replace damaged sections of geotextiles.

16 Firmly join together corrugated steel pipe sections with coupling bands, a smooth sleeve type
17 coupler or other approved mechanical methods.

18 Solvent cement the Schedule 40 PVC pipe and fittings together. Connect the HDPE pipe with
19 watertight neoprene connectors that are suitable for gravity flow conditions. Obtain approval
20 for all pipe fittings from the Engineer before delivery. Protect the open end of all outlet pipes
21 with a galvanized rodent screen as shown in plans. When the pipe perforations are not
22 distributed uniformly over the circumference of the pipe, lay perforated pipe with the
23 perforated segments of the pipe down. When plain pipe is called for by the plans, turn the
24 perforations up or use non-perforated pipe.

25 Where pipe is not placed in a trench install the amount of subdrain fine aggregate material
26 over and around the pipe as shown in the plans.

27 Install outlet fittings and outlet pipes with aggregate shoulder drains. Provide shoulder drain
28 pipes with positive drainage towards outlets. Establish positive drainage within 72 hours of
29 beginning trenching for installation of a given section of aggregate shoulder drain. Failure to
30 comply with this requirement may result in the Engineer restricting installation of additional
31 sections of aggregate shoulder drain until such time as the Contractor completes appropriate
32 outlet installations.

33 Compact the aggregate to a degree acceptable to the Engineer by the use of a vibratory
34 compactor before making the geotextile closure at the top of the trench.

35 Carefully place the backfill material after the pipe has been laid, so that the pipe will not be
36 disturbed by the backfilling operation. Firmly tamp all earth backfill material.

37 Connect the shoulder drains to existing drainage structures or to concrete pads at the outlet
38 end of the shoulder drain. Construct the concrete pad in accordance with Section 825 and
39 give an ordinary surface finish.

40 Furnish and install steel markers in accordance with the plans and use at all concrete pads.

41 **816-4 MEASUREMENT AND PAYMENT**

42 *Shoulder Drain* will be measured and paid as the actual number of linear feet that has been
43 completed and accepted, measured to the nearest foot along the centerline of the completed
44 shoulder drain aggregate. No measurement will be made along the outlet pipe.

45 ___" *Shoulder Drain Pipe* will be measured and paid in linear feet of all pipe that has been
46 incorporated into the completed and accepted work. Measurement will be made along the
47 pipe installation, including fittings, to the nearest 0.1 ft with no deduction made for fittings.

Section 818

1 ___" *Outlet Pipe for Shoulder Drain* will be measured and paid in linear feet of all pipe that
2 has been incorporated into the completed and accepted work. Measurement will be made
3 along the pipe installation, including fittings, to the nearest 0.1 ft with no deduction made for
4 fittings.

5 *Concrete Pad for Shoulder Drain Pipe Outlet* will be measured and paid in units of each for
6 the actual number of pads completed and accepted.

7 Such price and payment includes, but is not limited to, furnishing, hauling and placing all
8 pipe, fittings, shoulder drain aggregate, filtration geotextiles, concrete and other materials;
9 making all joint connections; cutting into and making connections to existing drainage
10 structures; grouting around the pipe where it enters existing drainage structures; pavement and
11 vertical markers; and all excavation and backfilling.

12 Replacement of damaged geotextile is incidental to the work in this section.

13 Payment will be made under:

Pay Item	Pay Unit
Shoulder Drain	Linear Foot
___" Shoulder Drain Pipe	Linear Foot
___" Outlet Pipe for Shoulder Drain	Linear Foot
Concrete Pad for Shoulder Drain Pipe Outlet	Each

14 **SECTION 818**
15 **BLOTTING SAND**

16 **818-1 DESCRIPTION**

17 Furnish and uniformly spread the blotting sand, as directed to prime coat, asphalt surface
18 treatment or asphalt curing seal.

19 **818-2 MATERIALS**

20 Refer to Division 10.

Item	Section
Blotting Sand	1012-3

21 **818-3 CONSTRUCTION METHODS**

22 Apply blotting sand upon completion of the asphalt application, when directed. Provide
23 relatively dry blotting sand. Spread uniformly, as directed, on the same day as the application
24 of prime coat, asphalt surface treatment or asphalt curing seal. Apply at the rate of 10 lb/sy of
25 surface area, unless otherwise directed.

26 **818-4 MEASUREMENT AND PAYMENT**

27 *Blotting Sand* will be measured and paid in tons that have actually been placed. The quantity
28 will be measured by weighing in trucks on certified platform scales or other certified
29 weighing devices. No deduction will be made of any moisture in the sand at the time of
30 weighing. No measurement of *Blotting Sand* will be made when it is part of a *Drag Seal* or
31 a *Sand Seal*.

32 Payment will be made under:

Pay Item	Pay Unit
Blotting Sand	Ton

Section 820

**SECTION 820
FUNNELS AND FUNNEL DRAINS**

820-1 DESCRIPTION

Furnish and install all funnels, pipe, elbows and other materials in accordance with the contract.

820-2 MATERIALS

Refer to Division 10.

Item	Section
Funnel Drain Pipe	1054-2(B)
Funnel Drain Pipe Elbows	1054-2(B)
Funnels	1054-2(A)
Portland Cement Concrete, Class B	1000

Use connector rings with gaskets in accordance with manufacturer's recommendations that are designed to form a properly sealed joint and provide circumferential and longitudinal strength sufficient to preserve the alignment and prevent separation of the sections

820-3 CONSTRUCTION METHODS

Furnish concrete, install and anchor funnel, and place connector ring with gaskets in accordance with the details in the plans and in accordance with manufacturer's recommendations so water will flow freely into it without overflow or leakage. Securely join the funnel drain pipe to the funnel and backfill with sufficient care so that no part of the funnel or funnel drain pipe is displaced or moved out of alignment. Place backfill material in 6" layers and compact to a density comparable to the adjacent undisturbed material.

Construct a temporary construction berm to divert runoff into the funnel until paved ditch, paved berm or curb is constructed.

820-4 MEASUREMENT AND PAYMENT

Metal Funnels will be measured and paid in units of each for the actual number of funnels installed and accepted. No separate payment will be made for the concrete and the connector ring with gaskets as such work will be incidental to *Metal Funnels*.

___" *Funnel Drain Pipe* will be measured and paid as the actual number of linear feet of pipe incorporated into the completed and accepted work. Measurement will be made by counting the number of joints used and multiplying the length of the joint. Where partial joints are used, measurement will be made along the longest length of the partial joint to the nearest 0.1 ft.

___" *Funnel Drain Pipe Elbows* will be measured and paid in units of each for the actual number of elbows installed and accepted.

Such price and payment includes, but is not limited to, metal funnels, funnel drain pipe and elbows, all excavation and backfilling, and construction and maintenance of temporary berms for diversion in accordance with the contract.

Payment will be made under:

Pay Item	Pay Unit
Metal Funnels	Each
___" Funnel Drain Pipe	Linear Foot
___" Funnel Drain Pipe Elbows	Each

SECTION 825
INCIDENTAL CONCRETE CONSTRUCTION

825-1 DESCRIPTION

This section consists of the general requirements for the construction of all incidental concrete construction. The provisions of Sections 838, 840, 846, 848, 850, 852, 853, 854, 855, 857 and 858 will prevail over any conflicting requirements of this section.

825-2 FORMS

(A) General

Maintain forms true to the required lines, grades and dimensions. Construct forms with material of such strength and with sufficient rigidity to prevent any appreciable deflection between supports. Provide mortar-tight forms with a fillet at sharp corners when indicated in the plans.

Design clamps, pins, metal spacers, anchorages and other connecting devices to hold the forms rigidly together. Construct or install any metal spacers or anchorages that are required within the forms so that the metal work can be removed to a depth of at least 1" from the exposed surface of the concrete without injury to the surface. The recess thus formed in the concrete shall have a diameter no greater than 1.5 times the depth.

Maintain the shape, strength, rigidity and surface smoothness of forms that are to be re-used at all times. Thoroughly clean all dirt, mortar and foreign material from forms before reusing. Thoroughly coat all inside form surfaces with commercial quality form oil or other equivalent coating before placing concrete.

(B) Wood Forms

Provide forms with a smooth and uniform texture. Make joints between forms tight and even so that no appreciable form marks remain after the forms are removed.

Do not use plywood sheets showing torn grain, worn edges, patches or other defects that impair the texture of concrete surfaces exposed to view.

(C) Metal Forms

Use metal forms of such thickness and rigidity that the forms will remain true to shape. Counter-sink bolt and rivet heads. Use only metal forms that present a smooth surface and line up properly. Keep metal forms free from all foreign matter that will discolor the concrete.

825-3 REINFORCEMENT

Furnish and place reinforcement as shown in the plans and in accordance with Section 425.

825-4 PLACING CONCRETE

Do not place concrete until the foundation, the adequacy of the forms, the placing of reinforcement and other embedded items have been inspected and approved.

Place concrete in daylight unless an approved lighting system is provided.

Remove all debris from the interior of forms in preparation for placing concrete. Moisten earth or base course surfaces on which concrete is to be placed immediately before placing concrete. Do not place concrete on excessively wet or frozen surfaces.

Place concrete in its final position in the forms within the time stipulated in Subarticle 1000-4(E).

Section 825

1 Place concrete to avoid segregation of the materials and the displacement of the
2 reinforcement. Thoroughly work the concrete during placement. Bring mortar against the
3 forms to produce a smooth finish, substantially free from water and air pockets or
4 honeycombs.

5 Do not place concrete when the air temperature, measured at the location of the concrete
6 operation in the shade away from artificial heat, is below 35°F unless permission is otherwise
7 granted. When such permission is granted, uniformly heat the aggregates and water to
8 a temperature no higher than 150°F. Place the heated concrete at a temperature of at
9 least 55°F and no more than 80°F.

10 **825-5 SLUMP TESTS**

11 Test the slump of the concrete in accordance with Article 420-6.

12 **825-6 FINISHING**

13 **(A) General**

14 Provide the type of finish required by the contract directly applicable to the work being
15 constructed.

16 **(B) Ordinary Surface Finish**

17 Remove all form ties or metal spacers to a depth of at least 1" below the surface of the
18 concrete and clean and fill the resulting holes or depressions with grout. Metal devices
19 with exposed cross-sectional area not exceeding approximately 0.05 sq.in. on surfaces
20 permanently in contact with earth fill may be broken off flush with the surface of the
21 concrete.

22 Remove all fins caused by form joints and other projections. Remove stains and
23 discoloration. Clean all pockets and fill with grout as directed. Thoroughly soak the
24 surface of all concrete with water before the application of a grout repair.

25 Use grout consisting of one part cement and 2 parts sand. Use cement from the same
26 source as originally incorporated in work. Cure the grout for at least 3 days. After the
27 grout has thoroughly hardened, rub the patch with a carborundum stone as required to
28 match the texture and color of the adjacent concrete.

29 On surfaces that are to be backfilled or surfaces that are enclosed, the removal of form
30 marks, fins and pockets; the rubbing of grouted areas to uniform color; and the removal
31 of stains and discoloration will not be required.

32 **(C) Sidewalk Finish**

33 Strike off fresh concrete and compact until a layer of mortar is brought to the surface.
34 Finish the surface to grade and cross section with a float, trowel smooth and finish with
35 a broom.

36 **(D) Rubbed Finish**

37 After the ordinary surface finish has been completed, thoroughly wet and rub the entire
38 surface. Use a coarse carborundum stone or other equally good abrasive to bring the
39 surface to a smooth texture and remove all form marks. Carefully stroke the surface with
40 a clean brush to finish the paste formed by rubbing. Alternatively, spread the paste
41 uniformly over the surface and allow it to take a reset. Finish by floating with a canvas,
42 carpet-faced or cork float or rub down with dry burlap.

43 **(E) Float Finish**

44 Finish the surface with a rough carpet float or other suitable device leaving the surface
45 even but distinctly sandy or pebbled in texture.

1 825-7 REMOVING FORMS

2 Do not remove forms from freshly placed concrete until it has hardened sufficiently to resist
3 spalling, cracking or any other damage.

4 825-8 PROTECTION FROM COLD WEATHER

5 When it is anticipated that the atmospheric temperature will fall below 35°F, protect concrete
6 in accordance with Subarticle 420-7(C). Protect concrete containing fly ash or ground
7 granulated blast furnace slag for at least 7 curing days. Protect all other concrete for at
8 least 3 curing days.

9 825-9 CURING

10 Cure concrete in accordance with Subarticle 700-9(B) immediately after finishing operations
11 are completed and surface water has disappeared. Where forms are removed before the
12 expiration of the required curing period, apply the curing compound immediately after the
13 forms are removed.

14 Cure each mass for 7 curing days. A “curing day” shall be defined as any consecutive
15 24 hour period, after finishing operations of the mass is completed, when the air temperature
16 adjacent to the mass does not fall below 40°F.

17 825-10 JOINTS**18 (A) General**

19 Construct joints at right angles to the surface of the concrete. Locate joints at right angles
20 to the longitudinal centerline of curb, curb and gutter, gutter, island, median, median
21 barrier and all paved areas, except where different joint locations are called for in the
22 plans.

23 Where concrete is to be placed adjacent to any existing slab or pavement that has
24 a broken or irregular edge, provide a reasonably vertical edge by sawing.

25 (B) Grooved Contraction Joints

26 Form grooved contraction joints by a tool specifically constructed for this purpose or by
27 sawing with an approved concrete saw.

28 Groove contraction joints to the depth shown in the plans and to a width between
29 1/4" and 1/2", unless otherwise shown in the plans. If formed by a tool, make a radius
30 of 1/8" at the corners of the adjacent concrete.

31 (C) Expansion Joints

32 Fill construction joints with an expansion joint filler. Cut the filler into the shape
33 necessary to fill the joint. Make the filler 1/2" thick unless indicated otherwise in the
34 plans. After the concrete has hardened cut the filler away to a depth of 1/2" to provide
35 space for the joint sealer.

36 Install an expansion joint adjacent to any existing slab, pavement or structure against
37 which new concrete is placed and at other locations detailed in the plans.

38 (D) Construction Joints

39 Construct construction joints as shown in the plans or where otherwise approved.

40 (E) Sawing Joints

41 Saw joints after the concrete has hardened sufficiently to be sawed without spalling and
42 raveling but no more than 24 hours after the concrete has been placed.

Section 828

1 **(F) Sealing Joints**

2 Seal all contraction and expansion joints, except otherwise specified, before the backfill
3 is placed.

4 Thoroughly clean the joint to remove all foreign matter. Dry joints before sealing.

5 Entirely fill joints to within 1/8" to 1/4" of the surface of the concrete with joint sealer.
6 Immediately remove any sealer spilled on the surface of the concrete.

7 Place joint sealer with equipment meeting the specifications of the manufacturer of the
8 sealer material.

9 **825-11 MEASUREMENT AND PAYMENT**

10 There will be no direct payment for the work covered by this section.

11 Payment at the contract prices for the various items covered by those sections of the *Standard*
12 *Specifications* directly applicable to the work being constructed will be full compensation for
13 all work covered by this section.

14 **SECTION 828**
15 **TEMPORARY STEEL COVER FOR MASONRY**
16 **DRAINAGE STRUCTURES**

17 **828-1 DESCRIPTION**

18 Install temporary steel plate covers on masonry drainage structures in accordance with the
19 details shown in the plans and as directed.

20 **828-2 MATERIALS**

21 Provide materials that are Grade A36 steel and the size and thickness shown on the detail in
22 the plans.

23 **828-3 MEASUREMENT AND PAYMENT**

24 *Temporary Steel Plate Covers for Masonry Drainage Structures* will be measured and paid in
25 units of each for the actual number of these items incorporated into the completed and
26 accepted work.

27 Payment will be made under:

Pay Item	Pay Unit
Temporary Steel Plate Covers for Masonry Drainage Structures	Each

28 **SECTION 830**
29 **BRICK MASONRY CONSTRUCTION**

30 **830-1 DESCRIPTION**

31 This work consists of the general requirements for all unreinforced brick masonry
32 construction. The requirements of Sections 838, 840 and 858 will prevail over any conflicting
33 requirements of this section.

34 **830-2 CONSTRUCTION METHODS**

35 Construct all concrete footings and all other concrete elements of the structure in accordance
36 with Section 825.

37 **830-3 MORTAR**

38 Machine mix mortar in accordance with Article 1040-8 for at least 90 seconds. Remove and
39 dispose of any mortar that has developed initial set or lost plasticity.

1 830-4 LAYING BRICK

2 Dampen brick when necessary to reduce the rate of absorption. Build brick masonry plumb
3 and true to the required dimensions. Place a header course approximately mid height of the
4 structure in structures less than 9 courses high. Place a header course every third course on
5 structures 9 courses high or higher. Use other types of bonding where indicated in the plans.

6 Completely fill brick joints and cavities with mortar. Make mortar joint thickness at least 3/8"
7 and no more than 5/8". Finish joints that will remain exposed after backfill with a concave
8 jointer. Flush cut all other joints.

9 Use spalls or bats only when shaping around irregular openings or when unavoidable to finish
10 out a course. Place a full brick at the corner and place the bat in the interior of the course
11 when necessary to finish out the course.

12 Clean spilled mortar from exposed exterior surfaces not backfilled.

13 830-5 PROTECTION FROM COLD WEATHER

14 Do not place masonry when the temperature is below 35°F unless adequate protection is
15 provided by a pre-approved method.

16 When it is anticipated that the atmospheric temperature will fall below 35°F protect masonry,
17 in accordance with Subarticle 420-7(C), for at least 3 curing days.

18 Define a "curing day" as any consecutive 24 hour period, beginning when the last masonry
19 unit is placed in the completed structure, during which the air temperature adjacent to the
20 structure does not fall below 40°F.

21 830-6 MEASUREMENT AND PAYMENT

22 There will be no direct payment for the work covered by this section.

23 Payment at the contract prices for the various items covered by those sections of the *Standard*
24 *Specifications* directly applicable to the work being constructed will be full compensation for
25 all work covered by this section.

26 SECTION 832**27 REINFORCED BRICK MASONRY CONSTRUCTION****28 832-1 DESCRIPTION**

29 This work shall consist of the general requirements for all reinforced brick masonry
30 construction. The requirements of Section 838 will prevail over any conflicting requirements
31 of this section.

32 832-2 CONCRETE CONSTRUCTION

33 Construct concrete footings and all other concrete elements of the structure in accordance
34 with Section 825. Furnish and place reinforcement as shown in the plans and in accordance
35 with Section 425. Use Class A concrete for footings unless otherwise indicated in the plans.
36 Use Class B concrete in reinforcement cavities. Rod Class B concrete in reinforcement
37 cavities to provide a dense, homogeneous concrete. Do not vibrate.

38 832-3 MORTAR

39 Machine mix mortar that meets Article 1040-9 for at least 90 seconds. Remove and dispose
40 of any mortar that has developed initial set or lost plasticity.

41 832-4 LAYING BRICK

42 Dampen brick when necessary to reduce the rate of absorption. Construct the type of bond
43 called for in the plans. Build reinforced brick masonry plumb and true to the required
44 dimensions.

Section 834

1 Lay brick with completely filled mortar joints. Make mortar joint thickness at least 3/8" and
2 no more than 5/8". Finish joints that will remain exposed after backfill, with a concave
3 jointer. Flush cut all other joints.

4 Use spalls or bats only when shaping around irregular openings. Place a full brick at the
5 corner and place the bat in the interior of the course when necessary to finish out a course.

6 Clean spilled mortar from exposed exterior surfaces not backfilled.

7 832-5 PROTECTION FROM COLD WEATHER

8 Refer to Article 830-5.

9 832-6 MEASUREMENT AND PAYMENT

10 There will be no direct payment for the work covered by this section.

11 Payment at the contract unit prices for the various items covered by those sections of the
12 Specifications directly applicable to the work being constructed will be full compensation for
13 all work covered by this section.

SECTION 834 BLOCK MASONRY CONSTRUCTION

16 834-1 DESCRIPTION

17 This work consists of constructing concrete block masonry. The requirements of
18 Sections 840, 858 and 859 will prevail over any conflicting requirements of this section.

19 834-2 CONCRETE CONSTRUCTION

20 Construct concrete footings and all other concrete elements of the structure in accordance
21 with Section 825.

22 834-3 MORTAR

23 Machine mix mortar in accordance with Article 1040-9 for at least 90 seconds. Remove and
24 dispose of any mortar that has developed initial set or has lost plasticity.

25 834-4 LAYING CONCRETE BLOCK

26 Build block masonry plumb and true to the required dimensions. Stagger vertical joints. Set
27 the block with the cells vertical. Spread mortar on the bearing members and fill the vertical
28 joints with mortar. Dampen block when necessary to reduce the rate of absorption.

29 Make joints straight, level, plumb, and neat at intersection. Make mortar joint thickness at
30 least 3/8" and no more than 5/8". Finish joints that will remain exposed after backfill, with
31 a concave jointer. Flush cut all other joints. Clean exposed exterior surfaces of spilled mortar
32 that are not backfilled.

33 834-5 PROTECTION FROM COLD WEATHER

34 Refer to Article 830-5.

35 834-6 COMPENSATION

36 There will be no direct payment for the work covered by this section.

37 Payment at the contract prices for the various items covered by those sections of the *Standard*
38 *Specifications* directly applicable to the work being constructed will be full compensation for
39 all work covered by this section.

SECTION 838
ENDWALLS

1
2

3 **838-1 DESCRIPTION**

4 Perform the work covered by this section including but not limited to excavation, hauling,
5 disposal of materials, furnishing and placing backfill materials, subsurface drainage, concrete,
6 brick masonry, mortar, grout, and furnishing and placing reinforcing steel to construct
7 Portland cement concrete or brick masonry endwalls, either plain or reinforced, in accordance
8 with the contract.

9 **838-2 MATERIALS**

10 Refer to Division 10:

Item	Section
Brick	1040-1
Curing Agents	1026
Mortar	1040-9
Precast Concrete Units	1077
Portland Cement Concrete, Class B	1000
Reinforcing Steel	1070-2
Select Material	1016
Stone, No 78M	1005
Subdrain Fine Aggregate	1044-1

11 Use Portland cement concrete, brick masonry or precast concrete for the endwall unless
12 otherwise specified in the plans.

13 If precast sections are proposed, submit in writing for approval.

14 **838-3 CONSTRUCTION METHODS.**

15 **(A) Foundation**

16 Do not place concrete or masonry until the foundation is approved.

17 Excavate foundation to a firm surface, make level or stepped and clean surfaces of loose
18 material. Make excavation true to lines and dimensions shown on plans.

19 Where the foundation material is found to be of poor supporting value or of rock, the
20 Engineer may make minor adjustments in the location of the structure to provide a more
21 suitable foundation. Where this is not practical, undercut the foundation and condition by
22 backfilling with an approved select material.

23 **(B) Concrete and Masonry**

24 Construct concrete in accordance with Section 825 and give an ordinary surface finish.
25 Construct brick masonry in accordance with Sections 830 and 832. Furnish and place
26 reinforcing steel in accordance with Section 425.

27 Provide the class of concrete indicated in the plans.

28 Obtain approval if field conditions necessitate a variance from the plan dimensions of the
29 structure and footings.

30 Construct endwalls on the end of a full joint of pipe and in accordance with the details in
31 the plans.

32 Any endwall that incorporates an opening for circular pipe 54" or greater shall be
33 reinforced.

Section 840

1 **(C) Backfill**

2 Complete endwall construction, and remove all forms. Backfill with approved material
3 after the concrete or brick masonry has cured for at least 7 curing days unless otherwise
4 permitted. A “curing day” is defined in Article 830-5. Within 4 calendar days after the
5 completion of the 7 day curing period, shape, compact and complete backfill in
6 accordance with the contract.

7 **838-4 MEASUREMENT AND PAYMENT**

8 *Endwalls* will be measured and paid in cubic yards of concrete or brick completed and
9 accepted. This quantity will be computed from the dimensions shown in the plans or from
10 revised authorized dimensions. Where precast concrete units have been approved and are
11 used instead of cast-in-place units the quantity to be paid will be computed the same as if
12 cast-in-place units were used, as no reduction in pay quantity will be made due to the use of
13 precast instead of cast-in-place endwalls.

14 *Reinforced Endwalls* will be measured and paid in cubic yards of concrete or brick completed
15 and accepted. This quantity will be computed from the dimensions shown in the plans or
16 from revised authorized dimensions. Where precast concrete units have been approved and
17 are used instead of cast-in-place units the quantity to be paid will be computed the same as if
18 cast-in-place units were used, as no reduction in pay quantity will be made due to the use of
19 precast instead of reinforced cast-in-place endwalls.

20 Payment will be made under:

Pay Item	Pay Unit
Endwalls	Cubic Yard
Reinforced Endwalls	Cubic Yard

21 **SECTION 840**
22 **MINOR DRAINAGE STRUCTURES**

23 **840-1 DESCRIPTION**

24 Perform the work covered by this section including, but not limited to, excavation; providing
25 protection of employees in excavation; hauling; disposal of materials; removing existing pipe
26 and drainage structures at the site of the work; furnishing, transporting and placing foundation
27 conditioning material, backfill material, subsurface drainage, concrete, brick masonry, block
28 masonry, precast units, mortar, grout, reinforcing steel, hardware, castings and miscellaneous
29 metal; fabrication; welding; and galvanizing to construct cast-in-place concrete, brick
30 masonry, block masonry or precast concrete inlets, catch basins, junction boxes, spring boxes,
31 manholes, concrete aprons and other minor drainage structures excluding endwalls, with all
32 necessary metal grates, covers, frames, steps and other hardware, in accordance with the
33 contract.

34 Use cast-in place concrete, brick masonry, block masonry or precast concrete construction as
35 shown on approved plans.

36 **840-2 MATERIALS**

37 Refer to Division 10.

Item	Section
Brick	1040-1
Concrete Block	1040-2
Curing Agents	1026
Fabricated Steel Grates	1074-9
Gray Iron Castings	1074-7
Joint Fillers	1028-1
Joint Sealers	1028-2

Item	Section
Mortar	1040-9
Precast Drainage Structure Units	1077
Portland Cement Concrete, Class B	1000
Reinforcing Steel	1070
Select Materials	1016
Steps	1074-8
Structural Steel	1072

1 Use grout in precast structures consisting of one part Portland cement to 2 parts of mortar
2 sand.

3 Use foundation conditioning material meeting Article 1016-3 for Class V or VI select material
4 as shown in the contract or as directed.

5 **840-3 CONSTRUCTION METHODS**

6 **(A) Excavation**

7 Perform excavation with equipment of adequate weight, size and capability. Where
8 necessary, provide a competent person and protection of personnel in excavation by
9 sloping, shoring or bracing in accordance with Federal, State or local standards and
10 Article 107-1.

11 **(B) Foundation**

12 Do not place masonry drainage structure until the foundation has achieved adequate
13 strength.

14 Where the foundation material is found to be of poor supporting value or of rock, minor
15 adjustments in the location of the structure may be approved to provide a more suitable
16 foundation. Where this is not practical, undercut the foundation and condition by
17 backfilling with an approved select material.

18 Set precast foundation slabs to within $\pm 1/2$ " of grade on a 2" to 3" thick bed of
19 compacted foundation conditioning material.

20 **(C) Cast-In-Place Concrete, Brick and Block Masonry**

21 Install drainage structures to plan line and grade or approved to meet drainage conditions.
22 Do not modify the drainage structure by corbeling or use of concrete slabs unless
23 otherwise directed.

24 Construct concrete in accordance with Section 825 and give an ordinary surface finish.
25 Construct brick masonry in accordance with Section 830. Construct block masonry in
26 accordance with Section 834. Furnish and place reinforcing steel in accordance with
27 Section 425.

28 Obtain approval if field conditions necessitate a variance from the plan dimensions of the
29 structure or footings.

30 **(D) Installation of Precast Units**

31 Install drainage structures to plan line and grade or approved to meet drainage conditions.
32 Do not modify the drainage structure by corbeling or use of concrete slabs unless
33 otherwise directed.

34 Assemble the precast drainage structure units in accordance with the manufacturer's
35 instructions. Subarticle 840-3(C) applies where it is necessary to use cast-in-place
36 concrete, brick masonry or block masonry construction as part of the structure. Fill any
37 void greater than 1" with a brick or block bat fully encased in mortar.

Section 840

1 Obtain approval if field conditions necessitate a variance from the plan dimensions of the
2 structure or footings.

3 (E) Fittings and Connections

4 As the work is built up, accurately space, align and thoroughly bond fittings that enter the
5 structure.

6 Make pipe connections so the pipe does not project beyond the inside wall of the
7 drainage structure and grout as necessary to make smooth and uniform surfaces on the
8 inside of the structure.

9 Set metal frames for grates and covers in full mortar beds or secure by approved methods.

10 (F) Backfill

11 Complete drainage structure and remove all forms and falsework. Backfill with approved
12 material, compacted to the density required by Subarticle 235-3(C), after the drainage
13 structure has cured for at least 7 curing days, unless otherwise permitted. Define
14 a "curing day" in accordance with Article 825-9 for concrete or Article 830-5 for brick or
15 block masonry.

16 (G) Pipe Collars and Pipe Plugs

17 Construct pipe collars and pipe plugs in accordance with the details shown in the plans or
18 as directed.

19 Use any class of Portland cement concrete contained within Section 1000 for pipe collars.

20 Construct pipe plugs with either brick masonry or any class of Portland cement concrete
21 contained within Section 1000.

22 (H) Concrete Aprons

23 Construct concrete aprons in accordance with the details in the plans. Use Class B or
24 higher compressive strength concrete.

25 840-4 MEASUREMENT AND PAYMENT

26 *Masonry Drainage Structure* that incorporate an opening for circular pipe not exceeding 48"
27 in diameter will be measured and paid in units of each for the actual number completed and
28 accepted.

29 *Masonry Drainage Structure* exceeding a height of 5.0 ft will be measured and paid in linear
30 feet for the portion of the drainage structure exceeding a height of 5.0 ft. The height will be
31 measured vertically to the nearest 0.1 ft from the top of the bottom slab to the top of the wall.
32 For that portion of *Masonry Drainage Structure* measured above a height of 10.0 ft, payment
33 will be made at 1.3 times the contract unit price per linear foot for *Masonry Drainage*
34 *Structure*.

35 *Masonry Drainage Structures* that incorporate an opening for circular pipe exceeding 48" in
36 diameter, or for pipe arch of any size, will be measured and paid on a volume basis as
37 provided below.

38 Masonry to be paid will be the number of cubic yards of cast-in-place concrete brick or block
39 that has been incorporated into the completed and accepted structure. This quantity will be
40 computed from the dimensions shown in the plans or from revised dimensions authorized by
41 the Engineer. Where the wall thickness is greater than the wall thickness shown in the plans
42 due to the use of oversize brick or for any other reason, the wall thickness shown in the plans
43 will be used to compute quantities except where an increase in wall thickness has been
44 authorized by the Engineer.

Section 840

- 1 *Pipe Collars* will be measured and paid in cubic yards of concrete or brick that has been
2 incorporated into the completed work. The cubic yards of pipe collars will be computed from
3 the dimensions shown in the plans or from revised dimensions authorized by the Engineer.
- 4 *Pipe Plugs* will be measured and paid in cubic yards of concrete or brick that has been
5 incorporated into the completed and accepted pipe plug. The cubic yards of pipe plugs will be
6 computed from the dimensions shown in the plans or from revised dimensions authorized by
7 the Engineer.
- 8 *Frame with Grate and Hood, Std. ____* will be measured and paid in units of each for actual
9 number of assemblies incorporated into the completed work. No separate measurement will
10 be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods and
11 covers will be considered to be part of the complete assembly.
- 12 *Frame with Grate, Std. ____* will be measured and paid in units of each for actual number of
13 assemblies incorporated into the completed work. No separate measurement will be made of
14 grates, hoods, and covers that are part of the assembly, as the grates, hoods and covers will be
15 considered to be part of the complete assembly.
- 16 *Frame with Two Grates, Std. ____* will be measured and paid in units of each for actual
17 number of assemblies incorporated into the completed work. No separate measurement will
18 be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods and
19 covers will be considered to be part of the complete assembly.
- 20 *Frame with Cover, Std. ____* will be measured and paid in units of each for actual number of
21 assemblies incorporated into the completed work. No separate measurement will be made of
22 grates, hoods, and covers that are part of the assembly, as the grates, hoods and covers will be
23 considered to be part of the complete assembly.
- 24 *Steel Frame with Two Grates, Std. ____* will be measured and paid in units of each for the
25 actual number of fabricated steel grates incorporated into the completed work.
- 26 No separate payment will be made for concrete aprons shown in *Roadway Standard Drawings*
27 No. 840.17, 840.18, 840.19, 840.26, 840.27 and 840.28, as this work will be incidental to the
28 other work in this section.
- 29 *Foundation Conditioning* will be paid as provided in Article 300-9.
- 30 The above prices and payments will be full compensation for all work covered by this section.
- 31 Payment will be made under:

Pay Item	Pay Unit
Masonry Drainage Structures	Each
Masonry Drainage Structures	Linear Foot
Masonry Drainage Structures	Cubic Yard
Pipe Collars	Cubic Yard
Pipe Plugs	Cubic Yard
Frame with Grate and Hood, Std. ____	Each
Frame with Grate, Std. ____	Each
Frame with Two Grates, Std. ____	Each
Frame with Cover, Std. ____	Each
Steel Frame with Two Grates, Std. ____	Each

1 (E) Backfilling

2 Do not place backfill or pavement adjacent to the curb, curb and gutter, gutter, shoulder
3 berm gutter, expressway gutter or concrete valley gutter until at least 3 curing days, as
4 defined in Article 825-9, have elapsed.

5 Complete backfill within 4 calendar days after the completion of the 3 day curing period
6 unless otherwise approved.

7 Compact backfill to an approved density.

8 (F) Opening to Traffic

9 Vehicles may be permitted on the completed work after the following curing days, as
10 defined in Article 825-9, have elapsed. For regular strength concrete, cure for at least
11 7 curing days. For high early strength concrete, cure for at least 3 curing days.

12 846-4 MEASUREMENT AND PAYMENT

13 *__" x __" Concrete Curb* will be measured and paid in linear feet, accepted in place, along the
14 surface of the top of the curb.

15 *__' __" Concrete Curb and Gutter* will be measured and paid in linear feet, accepted in place.
16 Measurement will be made along the surface of the top of the curb.

17 *__' Concrete Gutter* will be measured and paid in linear feet accepted in place. Measurement
18 will be made along the surface of the top of the curb.

19 *Shoulder Berm Gutter* will be measured and paid in linear feet, accepted in place.
20 Measurement will be made along the surface of the top of the curb.

21 *Concrete Expressway Gutter* will be measured and paid in linear feet, accepted in place.
22 Measurement will be made along the surface of the top of the curb.

23 *Concrete Valley Gutter* will be measured and paid in linear feet, accepted in place.
24 Measurement will be made along the surface of the top of the curb.

25 Work includes providing all materials, placing all concrete, excavating and backfilling,
26 forming, finishing, constructing and sealing joints, and all incidentals necessary to complete
27 the work.

28 Payment will be made under:

Pay Item	Pay Unit
<i>__" x __" Concrete Curb</i>	Linear Foot
<i>__' __" Concrete Curb and Gutter</i>	Linear Foot
<i>__' Concrete Gutter</i>	Linear Foot
<i>Shoulder Berm Gutter</i>	Linear Foot
<i>Concrete Expressway Gutter</i>	Linear Foot
<i>Concrete Valley Gutter</i>	Linear Foot

29 **SECTION 848**
30 **CONCRETE SIDEWALKS, DRIVEWAYS AND CURB RAMPS**

31 848-1 DESCRIPTION

32 Construct Portland cement concrete sidewalks, driveways and curb ramps in accordance with
33 the contract.

Section 848

1 **848-2 MATERIALS**

2 Refer to Division 10.

Item	Section
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-2, 1028-3
Portland Cement Concrete, Class B	1000

3 Detectable warnings may be precast concrete blocks or other approved material. Construct
4 detectable warning truncated domes in accordance with details and plan.

5 **848-3 CONSTRUCTION METHODS**

6 Where it is necessary to remove a portion of existing sidewalks or driveways, saw a neat edge
7 along the pavement to be retained approximately 2" deep with a concrete saw before breaking
8 the adjacent pavement away.

9 Construct concrete in accordance with Section 825 and give a sidewalk finish, except as
10 otherwise provided herein.

11 Broom the concrete surface in a transverse direction to traffic. Make joint spacing no less
12 than 5 ft. Where existing sidewalks are being widened, line up new transverse joints with
13 existing joints in the adjacent sidewalk. Seal expansion joints where sidewalk and curb ramps
14 are placed adjacent to concrete curb and/or gutter. Do not seal grooved joints.

15 Do not place backfill adjacent to the sidewalk, driveway or curb ramp until at least 3 curing
16 days, as defined in Article 825-9, have elapsed unless otherwise approved. Compact backfill
17 to a degree comparable to the adjacent undisturbed material.

18 Do not place vehicles on the completed work until 7 curing days, as defined in Article 825-9,
19 have elapsed. When high early strength concrete is used, vehicles will be permitted on the
20 completed work after 3 curing days have elapsed.

21 Install detectable warnings 24" in length of truncated dome paving blocks along the bottom of
22 the curb ramps in accordance with the plans and details. The surface of the domes shall
23 contrast visibly with adjoining surfaces, either light-on-dark or dark-on-light sequence
24 covering the entire ramp.

25 **848-4 MEASUREMENT AND PAYMENT**

26 ___" *Concrete Sidewalk* will be measured and paid in square yards, measured along the surface
27 of the completed and accepted work. Such price includes, but is not limited to, excavating
28 and backfilling, sawing the existing sidewalk, furnishing and placing concrete, and
29 constructing and sealing joints.

30 ___" *Concrete Driveway* will be measured and paid in square yards, measured along the
31 surface of the completed and accepted work. Such price includes, but is not limited to,
32 excavating and backfilling, sawing the existing driveway, furnishing and placing concrete,
33 and constructing and sealing joints.

34 *Concrete Curb Ramps* will be measured and paid in units of each. Such price includes, but is
35 not limited to, excavating and backfilling, sawing the existing sidewalk or driveway,
36 furnishing and placing concrete, curb and gutter, constructing and sealing joints and
37 furnishing and installing truncated domes shown in the *Roadway Standard Drawings*.

38 Payment will be made under:

Pay Item	Pay Unit
___" Concrete Sidewalk	Square Yard
___" Concrete Driveway	Square Yard
Concrete Curb Ramps	Each

**SECTION 850
CONCRETE PAVED DITCH**

1

2

3 **850-1 DESCRIPTION**

4 Construct Portland cement concrete paved ditches as shown in the plans for the various types
5 of ditches. Work includes, but is not limited to, all excavating and backfilling, furnishing and
6 placing concrete, constructing curtain walls and constructing and sealing joints.

7 **850-2 MATERIALS**

8 Refer to Division 10.

Item	Section
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-2, 1028-3
Portland Cement Concrete, Class B	1000

9 **850-3 CONSTRUCTION METHODS**

10 Construct concrete in accordance with Section 825 and give a sidewalk finish, except as
11 otherwise provided herein.

12 Broom the concrete surface transverse to the longitudinal centerline of the paved ditch. Make
13 joint spacing no less than 5 ft.

14 Do not place backfill adjacent to the paved ditch until at least 3 curing days have elapsed,
15 unless otherwise approved. Compact backfill to a degree comparable to the adjacent
16 undisturbed material.

17 **850-4 MEASUREMENT AND PAYMENT**

18 ___" *Concrete Paved Ditch* will be measured and paid in square yards that is completed and
19 accepted. Longitudinal measurements will be made along the surface of the pavement at the
20 centerline of the ditch and transverse measurements will be made along the surface of the
21 pavement at right angles to the centerline. No measurement will be made of curtain walls at
22 the beginning or ends of the paved ditches.

23 Payment will be made under:

Pay Item	Pay Unit
___" Concrete Paved Ditch	Square Yard

24

**SECTION 852
TRAFFIC ISLANDS AND MEDIANS**

25

26 **852-1 DESCRIPTION**

27 Construct traffic islands and medians of the type required by the plans. Perform the work in
28 accordance with the contract.

29 **852-2 MATERIALS**

30 Refer to Division 10.

Item	Section
Curing Agents	1026
Herbicide	1060-13
Joint Fillers	1028-1
Joint Sealers	1028-2, 1028-3
Portland Cement Concrete, Class B	1000

Section 852

852-3 CONSTRUCTION METHODS

Construct curb and curb and gutter, in accordance with Section 846.
Uniformly grade and compact the earth or base course under any island or median to the same requirements as the surrounding material.

Where necessary, treat aggregate and subgrade beneath other types of bases or directly beneath any concrete with a herbicide in accordance with Article 1670-7.

Construct concrete in accordance with Section 825 and give a sidewalk finish, except as otherwise provided herein. Broom concrete surfaces in medians transverse to the direction of traffic unless otherwise directed. Locate joints in island and median covers to line up with the joints in the curb and curb and gutter wherever possible. Locate joints in monolithic concrete islands and medians constructed adjacent to concrete pavement to line up with the joints in the concrete pavement wherever possible. Seal all joints.

Form openings in the island or island cover to accommodate sign posts.

852-4 MEASUREMENT AND PAYMENT

___" *Concrete Island Cover* will be measured and paid in square yards of concrete island cover that has been placed and accepted. Measurement will be made along the top surface of the completed island cover. This work includes, but is not limited to, excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts and constructing and sealing joints.

___" *Monolithic Concrete Islands* () will be measured and paid in square yards of concrete island that has been placed and accepted. Measurement will be made parallel to the bottom surface of the island or median. This work includes, but is not limited to, excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts and constructing and sealing joints.

___" *Monolithic Concrete Median* () will be measured and paid in square yards of concrete median that has been placed and accepted. Measurement will be made parallel to the bottom surface of the island or median. This work includes, but is not limited to, excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts and constructing and sealing joints.

Concrete Transitional Section for Catch Basin will be measured and paid in units of each.

Concrete Transitional Section for Drop Inlet will be measured and paid in units of each.

Payment for constructing earth fill will be made in accordance with Article 225-7 for *Unclassified Excavation* or Article 230-5 for *Borrow Excavation*, depending on the source of the material.

Payment for establishing a grass cover in unpaved island areas will be in accordance with Article 1660-8.

Payment for constructing *Concrete Curb* and *Concrete Curb and Gutter* will be made in accordance with Article 846-4.

Payment will be made under:

Pay Item	Pay Unit
___" Concrete Island Cover	Square Yard
___" Monolithic Concrete Islands ()	Square Yard
___" Monolithic Concrete Median ()	Square Yard
Concrete Transitional Section for Catch Basin	Each
Concrete Transitional Section for Drop Inlet	Each

**SECTION 854
CONCRETE BARRIER**

1
2

3 **854-1 DESCRIPTION**

4 Construct Portland cement concrete barrier in accordance with the contract. The concrete
5 barrier may be cast in place, slip formed or precast, unless otherwise specified in the contract.

6 **854-2 MATERIALS**

7 Refer to Division 10.

Item	Section
Connector Pins and Eye Assemblies	1072
Curing Agents	1026
Grout	1003
Guardrail and Barrier Delineators	1088-2
Joint Fillers	1028-1
Joint Sealers	1028-3
Portland Cement Concrete, Class AA	1000
Reinforcing Steel	1070-2

8 Galvanize connector pins and eye assemblies in accordance with Section 1076.

9 Use clear curing compound.

10 Provide grout with a compressive strength at 3 days of at least 5,000 psi for portable concrete
11 barriers.

12 **854-3 CONSTRUCTION METHODS**

13 **(A) Cast in Place or Slip Formed**

14 Construct concrete in accordance with Section 825 and give an ordinary surface finish,
15 except as otherwise provided herein.

16 Construct joints in accordance with the details shown in the plans. Seal expansion joints.

17 **(B) Precast**

18 Construct concrete in accordance with Section 825 and give an ordinary surface finish,
19 except as otherwise provided herein. Use Class AA concrete.

20 Do not handle or remove the forms from barrier until the strength of the concrete reaches
21 at least 2000 psi as evidenced by nondestructive tests made in place by a rebound
22 hammer in accordance with ASTM C805.

23 Construct the base beneath the precast units to be equivalent to the adjacent pavement
24 structure.

25 Lift and place precast units using a two-point pick up, or other approved method that will
26 not overstress or damage the concrete. Do not use connectors for lifting purposes. Do
27 not use lifting devices or methods that will mar the surface of the concrete. Do not use
28 any precast unit that has been cracked, damaged, chipped, scarred or otherwise
29 disfigured.

30 **(C) Barrier Delineators**

31 Use any of the several alternate delineator types for barrier shown in the plans, but only
32 one delineator type for barrier at any one time throughout the project.

33 The delineators consist of a reflector and base or casing. Attach the delineator to the
34 barrier as shown in the plans. Only one attachment position will be permitted throughout
35 the project length.

Section 857

1 Position delineators perpendicular to the centerline of the road. Use yellow delineators in
2 the median and on the left side of one-way ramps, loops or other one-way facilities. Use
3 crystal delineators on the right side of divided highways, ramps, loops and all other one-
4 way or two-way facilities. In all cases, the color of the delineator shall supplement the
5 color of the adjacent edgelines.

6 **854-4 MEASUREMENT AND PAYMENT**

7 *Concrete Barrier, Type ____* will be measured and paid in linear feet of barrier that has been
8 completed and accepted. Measurement will be made along the top surface at the centerline of
9 the barrier completed and in place with no deduction made for joints.

10 *Variable Height Concrete Barrier, Type ____* will be measured and paid in linear feet of
11 barrier that has been completed and accepted. Measurement will be made along the top
12 surface at the centerline of the barrier completed and in place with no deduction made for
13 joints.

14 *Concrete Barrier Transition Section* will be measured and paid in units of each for transitions
15 completed and accepted.

16 There will be no measurement made of barrier delineators as they are incidental to the other
17 pay items in this section.

18 No direct payment will be made for the work of constructing any footing beneath the concrete
19 barrier or concrete barrier transition sections as payment at the various contract unit prices for
20 concrete barrier or concrete barrier transition sections will be full compensation for all such
21 work.

22 Price and payment includes, but is not limited to, excavating, furnishing and placing concrete,
23 reinforcing steel, grout and hardware; transporting and placing precast units; galvanizing;
24 constructing and sealing joints; and furnishing and installing barrier delineators.

25 Payment will be made under:

Pay Item	Pay Unit
Concrete Barrier, Type ____	Linear Foot
Variable Height Concrete Barrier, Type ____	Linear Foot
Concrete Barrier Transition Section	Each

26 **SECTION 857**
27 **PRECAST REINFORCED CONCRETE BARRIER – SINGLE FACED**

28 **857-1 DESCRIPTION**

29 Construct precast reinforced Portland cement concrete barrier in accordance with the contract.

30 **857-2 MATERIALS**

31 Comply with Article 854-2.

32 **857-3 CONSTRUCTION METHODS**

33 Construct concrete in accordance with Section 825 and give an ordinary surface finish, except
34 as otherwise provided herein.

35 Lift and place precast units using a two-point pick up or other approved method that will not
36 overstress or damage the concrete. Do not use lifting devices or methods that will mar the
37 surface of the concrete. Do not set any precast unit that is cracked, damaged, chipped, scarred
38 or otherwise disfigured.

1 When barrier is being constructed near traffic, do not start installation of the precast concrete
 2 barrier until all components are prepared for a complete continuous installation, including the
 3 guardrail and guardrail anchors approaching the barrier. Once work has begun on a barrier
 4 installation, continue the work to its completion unless weather or other conditions beyond the
 5 control of the Contractor interfere with the work.

6 Use any of the several alternate delineator types for barrier shown in the plans, but only one
 7 delineator type for barrier at any one time throughout the project.

8 The delineators consist of a reflector and base or casing. Attach the delineator to the barrier
 9 as shown in the plans. Only one attachment position will be permitted throughout the project
 10 length.

11 Position delineators perpendicular to the centerline of the road. Use yellow delineators in the
 12 median and on the left side of one-way ramps, loops or other one-way facilities. Use crystal
 13 delineators on the right side of divided highways, ramps, loops and all other one-way or
 14 two-way facilities. In all cases, the color of the delineator shall supplement the color of the
 15 adjacent edgelines.

16 **857-4 MEASUREMENT AND PAYMENT**

17 There will be no measurement made of barrier delineators as they are incidental to the other
 18 pay items in this specification.

19 *Precast Reinforced Concrete Barrier, Single Faced* will be measured and paid in linear feet of
 20 barrier that has been completed, placed on the road and accepted. Measurement will be made
 21 along the top surface at the centerline of the barrier with no deduction made for joints. Price
 22 includes, but is not limited to, furnishing and placing concrete and reinforcing steel,
 23 transporting and placing precast units, grout, joint filler, hardware, galvanizing, constructing
 24 joints and furnishing and installing barrier delineators.

25 *Concrete Barrier Transition Section* will be paid in accordance with Section 854.

26 Payment will be made under:

Pay Item	Pay Unit
Precast Reinforced Concrete Barrier, Single Faced	Linear Foot

27 **SECTION 858** 28 **ADJUSTMENT OF CATCH BASINS, MANHOLES, DROP INLETS,** 29 **METER BOXES AND VALVE BOXES**

30 **858-1 DESCRIPTION**

31 Raise or lower existing catch basins, manholes, drop inlets, meter boxes and valve boxes
 32 encountered within the limits of the project to match the adjacent finished work.

33 **858-2 MATERIALS**

34 Refer to Division 10.

Item	Section
Asphalt Plant Mix	1020
Brick	1040-1
Concrete Block	1040-2
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028
Mortar	1040-9
Portland Cement Concrete, Class B	1000
Precast Risers	1077

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Item	Section
Reinforcing Steel	1070
Steps	1074-8

1 858-3 CONSTRUCTION METHODS

2 Perform the adjustment with brick masonry, block masonry or Portland cement concrete on
3 existing walls in accordance with Subarticle 840-3(C).

4 Adjust manholes, meter boxes and valve boxes as provided above by using approved fittings.
5 When fittings are used, leave the existing walls in place and securely attach the fittings to the
6 existing walls or install in a manner that will eliminate movement of the fitting.

7 Backfill excavated areas in an existing pavement with Portland cement concrete. High early
8 strength concrete may be used. Wait at least 72 hours after the placement of the concrete
9 before placing any surfacing or resurfacing material over the concrete. This time period will
10 not be required where the strength of the concrete is at least 2,500 psi as evidenced by
11 nondestructive tests made in place by a rebound hammer in accordance with ASTM C805.
12 Thoroughly compact backfill of other excavated areas.

13 In areas to be opened to traffic, construct a temporary ramp of asphalt plant mix 360° around
14 the adjusted structures within one calendar day after completing the adjustment. Construct
15 the ramp with a tapered slope of not less than one foot per inch of height in traffic sections
16 with a speed limit of less than 35 mph and 1.5 ft per inch of height to a maximum of 3 ft from
17 the structure in traffic sections with a speed limit of 35 mph or higher. Construct the ramp
18 using any type of asphalt surface course plant mix meeting the requirements of any job mix
19 formula issued by the Department for a Department project. Compact to an approved density.

20 Place bituminous plant mix flush with the top of the raised structure within 7 days after
21 raising the structure.

22 Make the adjustments before the final layer of surfacing material is placed in areas to be
23 surfaced or resurfaced. Salvage and reuse existing frames, grates, manhole covers, rings,
24 meter boxes and valve boxes in the adjustment.

25 858-4 MEASUREMENT AND PAYMENT

26 *Adjustment of Catch Basins* will be measured and paid in units of each for catch basins
27 satisfactorily adjusted.

28 *Adjustment of Drop Inlets* will be measured and paid in units of each for drop inlets
29 satisfactorily adjusted.

30 *Adjustment of Manholes* will be measured and paid in units of each for manholes satisfactorily
31 adjusted.

32 *Adjustment of Meter Boxes or Valve Boxes* will be measured and paid in units of each for
33 meter boxes or valve boxes satisfactorily adjusted.

34 Where any catch basin, drop inlet, manhole, meter box or valve box is adjusted more than
35 once because of milling operations, multiple adjustments will be counted as one adjustment.

36 Where a catch basin, manhole, drop inlet, meter box or valve box is raised more than 2 ft, the
37 number of linear feet exceeding 2 ft that such structure has been raised will be measured and
38 paid per linear foot as provided in Article 840-4 for *Masonry Drainage Structure*.
39 Measurement will be made by subtracting the elevation at the highest point of the original
40 structure from the elevation at the highest point of the adjusted structure and then subtracting
41 2 ft from the results.

1 Such price includes, but is not limited to, excavation and backfilling, removal of a portion of
 2 the existing structure, brick masonry, mortar, grout, concrete, reinforcing steel, fittings,
 3 furnishing and hauling asphalt plant mix and any other materials and placing, maintaining,
 4 removing and disposing of traffic ramps.

5 Payment will be made under:

Pay Item	Pay Unit
Adjustment of Catch Basins	Each
Adjustment of Drop Inlets	Each
Adjustment of Manholes	Each
Adjustment of Meter Boxes or Valve Boxes	Each

6 **SECTION 859**
 7 **CONVERTING EXISTING CATCH BASINS, DROP INLETS AND**
 8 **JUNCTION BOXES**

9 **859-1 DESCRIPTION**

10 Convert existing catch basins, drop inlets and junction boxes to catch basins, drop inlets or
 11 junction boxes, including all necessary construction and reconstruction in accordance with the
 12 contract.

13 **859-2 MATERIALS**

14 Refer to Division 10.

Item	Section
Brick	1040-1
Concrete Block	1040-2
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-3
Mortar	1040-9
Portland Cement Concrete, Class B	1000
Reinforcing Steel	1070
Steps	1074-8
Stone, No. 78M	1005
Structural Steel	1072

15 **859-3 CONSTRUCTION METHODS**

16 Perform work in accordance with Article 840-3 and the details shown in the plans. Raise or
 17 lower the existing catch basins and drop inlets as required by the plans and provisions.

18 **859-4 MEASUREMENT AND PAYMENT**

19 *Convert Existing Catch Basin to Junction Box* will be measured and paid in units of each
 20 drainage structure that has been acceptably converted.

21 *Convert Existing Catch Basin to Drop Inlet* will be measured and paid in units of each
 22 drainage structure that has been acceptably converted.

23 *Convert Existing Catch Basin to Junction Box with Manhole* will be measured and paid in
 24 units of each drainage structure that has been acceptably converted.

25 *Convert Existing Drop Inlet to Junction Box* will be measured and paid in units of each
 26 drainage structure that has been acceptably converted.

27 *Convert Existing Drop Inlet to Catch Basin* will be measured and paid in units of each
 28 drainage structure that has been acceptably converted.

Section 862

- 1 *Convert Existing Drop Inlet to Junction Box with Manhole* will be measured and paid in units
2 of each drainage structure that has been acceptably converted.
- 3 *Convert Existing Junction Box to Drop Inlet* will be measured and paid in units of each
4 drainage structure that has been acceptably converted.
- 5 *Convert Existing Junction Box to Catch Basin* will be measured and paid in units of each
6 drainage structure that has been acceptably converted.
- 7 If grates and frames are necessary in converting either catch basins or drop inlets or if frames
8 and covers are necessary for junction boxes, separate payment will be made for the grates and
9 frames or cover and frame in accordance with Section 840.
- 10 Such price will include, but is not limited to, excavating, hauling, removal of a portion of the
11 existing structures, disposal of materials, furnishing, transporting, placing backfill material,
12 subsurface drainage, concrete, brick masonry, mortar, grout, reinforcing steel, hardware,
13 casting, miscellaneous metal, fabricating, welding and galvanizing.
- 14 Payment will be made under:

Pay Item	Pay Unit
Convert Existing Catch Basin to Junction Box	Each
Convert Existing Catch Basin to Drop Inlet	Each
Convert Existing Catch Basin to Junction Box with Manhole	Each
Convert Existing Drop Inlet to Junction Box	Each
Convert Existing Drop Inlet to Catch Basin	Each
Convert Existing Drop Inlet to Junction Box with Manhole	Each
Convert Existing Junction Box to Drop Inlet	Each
Convert Existing Junction Box to Catch Basin	Each

15 **SECTION 862** 16 **GUARDRAIL**

17 **862-1 DESCRIPTION**

- 18 Construct either permanent or temporary steel beam guardrail, in accordance with the contract
19 and at the locations designated in the plans or as directed.

20 **862-2 MATERIALS**

- 21 Refer to Division 10.

Item	Section
Anchors	1046-5
Guardrail and Barrier Delineators	1088-2
Guardrail End Delineation	1088-3
Hardware	1046-4
Organic Zinc Repair Paint	1080-9
Posts and Offset Blocks	1046-3
Rail Elements	1046-2
Select Material, Class VI	1016
Welded Wire Reinforcement	1070-3

- 22 Supply material in accordance with the Department's Brand Certification Program for
23 Guardrail.

- 24 Temporary guardrail shall be of the type called for in the plans and shall be fabricated from
25 plates that are at least 12 gauge in thickness. Used materials are acceptable for temporary
26 guardrail construction provided their condition is approved.

1 862-3 CONSTRUCTION METHODS

2 Erect the rail elements to produce a smooth continuous rail paralleling the line and grade of
3 the highway surface or as shown in the plans. Lap the rail elements in the direction of traffic.
4 Re-lap the rail elements if required by traffic phasing. Field drill holes for special details.
5 Field punching holes is allowed. Attach terminal sections, when required, to the ends of each
6 installation and lap on the face of the rail.

7 Install shop curve guardrail in accordance with the plans.

8 Posts may be power driven, or set by hand. Protect the top of steel posts by a suitable driving
9 cap if power driven. If set by hand, dig post holes to the depth and at the locations shown in
10 the plans. Thoroughly ram the bottom of the post holes so that the posts will have a stable
11 foundation. Set the posts plumb and accurately space and line. Backfill the post holes in
12 6" layers with suitable material and thoroughly compact.

13 Where rock interferes with the proper installation of the post, excavate a shaft in the rock at
14 least 9" wide, parallel to the roadway, by 23" long, perpendicular to the roadway and
15 24" deep. Place the post against the roadside edge of the shaft and fill in behind the post with
16 Class VI select material, up to the top elevation of the rock. Fill the remainder of the hole
17 with earth material. Where timber posts are to be driven in fill slopes 1.5:1 or steeper and the
18 fill height is 15 ft or more, auger a 6" diameter pilot hole to the full depth of the post before
19 driving.

20 Where steel posts are required to be installed at box culverts, weld the post to the anchor
21 plate, cut off and align in accordance with the details shown in the plans or as directed.

22 Use the same type of guardrail posts and offset blocks throughout the project unless otherwise
23 directed or detailed in the plans.

24 After galvanized guardrail has been erected, repair damaged coating in accordance with
25 Article 1076-7.

26 When guardrail is being constructed near traffic, conduct operations to constitute the least
27 hazard to the public. Schedule and conduct operations to construct and complete each
28 individual continuous guardrail installation in the least possible time.

29 Do not begin work on any section of new guardrail until preparations are made to fully
30 complete the installation of the section as a continuous operation. Once work begins on
31 a section, pursue the work to its completion unless inclement weather or other conditions
32 beyond the control of the Contractor interfere with the work. Begin attachment of the rail
33 elements at the approach end of the guardrail and continue in the same direction as the
34 movement of traffic.

35 When directed, install guardrail posts and blocks at locations that are in addition to those
36 required by the plans.

37 Install tubular triple corrugated steel beam guardrail on concrete bridges or driven posts or at
38 locations shown in the plans in accordance with the details shown in the plans and as directed.

39 Where the tubular triple corrugated steel beam guardrail is to be mounted on concrete, use
40 steel posts, weld the post to the anchor plate, cut off and align in accordance with the details
41 shown in the plans or as directed.

42 862-4 GUARDRAIL DELINEATORS

43 Use any of the several alternate delineator types for guardrail shown in the plans, but only one
44 delineator type for guardrail at any one time throughout the project.

45 The delineators consist of a reflector and base or casing. Attach the delineator to the guardrail
46 as shown in the plans. Only one attachment position will be permitted throughout the project
47 length.

Section 862

1 Position delineators perpendicular to the centerline of the road. Use yellow delineators in the
2 median and on the left side of one-way ramps, loops or other one-way facilities. Use crystal
3 delineators on the right side of divided highways, ramps, loops and all other one-way or
4 two-way facilities. In all cases, the color of the delineator shall supplement the color of the
5 adjacent edgelines.

6 **862-5 TEMPORARY GUARDRAIL**

7 Temporary guardrail may be reused if it is in satisfactory condition. After temporary
8 guardrail is no longer needed, it becomes the property of the Contractor. Remove the
9 temporary guardrail from the project.

10 **862-6 MEASUREMENT AND PAYMENT**

11 *Steel Beam Guardrail* will be measured and paid in linear feet of guardrail that has been
12 satisfactorily completed and accepted exclusive of that length of guardrail that is within the
13 pay limits of guardrail anchors. Measurement will be made from center to center of the
14 outermost post in the length of guardrail being measured.

15 *Steel Beam Guardrail, Shop Curved* will be measured and paid in linear feet of guardrail that
16 has been satisfactorily completed and accepted exclusive of that length of guardrail that is
17 within the pay limits of guardrail anchors. Measurement will be made from center to center
18 of the outermost post in the length of guardrail being measured.

19 *Steel Beam Guardrail, Double Faced* will be measured and paid in linear feet of guardrail that
20 has been satisfactorily completed and accepted exclusive of that length of guardrail that is
21 within the pay limits of guardrail anchors. Measurement will be made from center to center
22 of the outermost post in the length of guardrail being measured.

23 *Triple Corrugated Steel Beam Guardrail* will be measured and paid in linear feet of guardrail
24 that has been satisfactorily completed and accepted exclusive of that length of guardrail that is
25 within the pay limits of guardrail anchors. Measurement will be made from center to center
26 of the outermost post in the length of guardrail being measured.

27 *20" Tubular Triple Corrugated Steel Beam Guardrail* will be measured and paid in linear feet
28 of guardrail that has been satisfactorily completed and accepted exclusive of that length of
29 guardrail that is within the pay limits of guardrail anchors. Measurement will be made from
30 center to center of the outermost post in the length of guardrail being measured.

31 *Temporary Steel Beam, Guardrail* will be measured and paid in linear feet of guardrail that
32 has been satisfactorily completed and accepted exclusive of that length of guardrail that is
33 within the pay limits of guardrail anchors. Measurement will be made from center to center
34 of the outermost post in the length of guardrail being measured.

35 *Temporary Steel Beam Guardrail, Shop Curved* will be measured and paid in linear feet of
36 guardrail that has been satisfactorily completed and accepted exclusive of that length of
37 guardrail that is within the pay limits of guardrail anchors. Measurement will be made from
38 center to center of the outermost post in the length of guardrail being measured.

39 *Temporary Steel Beam Guardrail, Double Faced* will be measured and paid in linear feet of
40 guardrail that has been satisfactorily completed and accepted exclusive of that length of
41 guardrail that is within the pay limits of guardrail anchors. Measurement will be made from
42 center to center of the outermost post in the length of guardrail being measured.

43 *Steel Beam Guardrail Terminal Section* and *Temporary Steel Beam Guardrail Terminal*
44 *Sections* will be measured and paid in units of each completed and accepted, exclusive of
45 terminal sections that are within the pay limits of guardrail anchors.

46 *Triple Corrugated Steel Beam Guardrail Terminal Sections* will be measured and paid in
47 units of each completed and accepted, exclusive of terminal sections that are within the pay
48 limits of guardrail anchors.

1 *Guardrail Anchor Units, Type ____ and Temporary Guardrail Anchor Units Type ____* will
 2 be measured and paid as units of each completed and accepted. No separate measurement
 3 will be made of any rail, terminal sections, posts, offset blocks, concrete, hardware or any
 4 other components of the completed unit that are within the pay limits shown in the plans for
 5 the unit as all such components will be considered to be part of the unit.

6 *W-TR Steel Beam Guardrail Transition Sections* will be measured and paid in units of each
 7 completed and accepted.

8 *Additional Guardrail Posts* will be measured and paid in units of each for additional posts
 9 required but not shown in the plans.

10 There will be no measurement or payment made for guardrail delineators or guardrail end
 11 delineation as they are incidental to the other pay items in this section.

12 Such price and payment includes, but is not limited to, furnishing and erecting posts, offset
 13 blocks, rail, terminal sections, miscellaneous hardware and all other materials; field curving
 14 and shop curving of the rail; removing temporary guardrail; excavation; furnishing and
 15 installing additional guardrail posts and additional offset blocks; backfilling; fabrication;
 16 welding; galvanizing; and furnishing and installing guardrail delineators and end delineation.

17 Payment will be made under:

Pay Item	Pay Unit
Steel Beam Guardrail	Linear Foot
Steel Beam Guardrail, Shop Curved	Linear Foot
Steel Beam Guardrail, Double Faced	Linear Foot
Triple Corrugated Steel Beam Guardrail	Linear Foot
20" Tubular Triple Corrugated Steel Beam Guardrail	Linear Foot
Temporary Steel Beam Guardrail	Linear Foot
Temporary Steel Beam Guardrail, Shop Curved	Linear Foot
Temporary Steel Beam Guardrail, Double Faced	Linear Foot
Temporary Guardrail Anchor Units, Type ____	Each
Temporary Steel Beam Guardrail Terminal Sections	Each
Steel Beam Guardrail Terminal Sections	Each
Triple Corrugated Steel Beam Guardrail Terminal Sections	Each
Guardrail Anchor Units, Type ____	Each
W-TR Steel Beam Guardrail Transition Sections	Each
Additional Guardrail Posts	Each

18

SECTION 863

19

REMOVE EXISTING GUARDRAIL AND GUIDERAIL

20

863-1 GENERAL

21 Dismantle, remove and dispose of existing guardrail, guiderail and anchors of any type at
 22 locations shown in the plans or established by the Engineer.

23

863-2 CONSTRUCTION METHODS

24 Remove guardrail, guiderail and posts beginning at the trailing end and continuing towards
 25 the approach end. Remove the posts immediately after the rail or cable is removed.
 26 Complete post removal so that no posts without rail or cable attached are present at the end of
 27 any day's operations. Exercise care not to damage adjoining structures or other
 28 appurtenances. Fill any void created by post or anchor removal and repair all damages. All
 29 guardrail, guiderail and components removed are the property of the Contractor.

Section 864

1 **863-3 MEASUREMENT AND PAYMENT**

2 *Remove Existing Guardrail and Remove Existing Guiderail* will be measured and paid in
3 linear feet of guardrail or guiderail that has been satisfactorily removed. Measurement will be
4 made to the nearest 1.0 foot from center to center of the outermost post or end shoe center bolt
5 in the length of the guardrail or guiderail being removed. Measurement will be made before
6 removing the guardrail or guiderail.

7 The work to fill any void or fix all damage created by post or anchor removal is incidental to
8 the work of this section.

9 Payment will be made under:

Pay Item	Pay Unit
Remove Existing Guardrail	Linear Foot
Remove Existing Guiderail	Linear Foot

10 **SECTION 864**
11 **REMOVE AND RESET EXISTING GUARDRAIL AND GUIDERAIL**

12 **864-1 GENERAL**

13 Remove and reset existing guardrail, guiderail and anchors of any type at locations shown in
14 the plans and the contract.

15 **864-2 CONSTRUCTION METHODS**

16 Exercise care not to damage adjoining structures or other appurtenances. Fill any void created
17 by post or anchor removal and repair all damage at no cost to the Department. Reset existing
18 guardrail and guiderail in accordance with Articles 862-3 and 865-3. Reset guardrail and
19 guiderail in a condition that is equal to or better than the condition that exists before the
20 guardrail and guiderail is removed. Replace any of the guardrail and guiderail components
21 unnecessarily damaged.

22 **864-3 MEASUREMENT AND PAYMENT**

23 *Remove and Reset Existing Guardrail* will be measured and paid in linear feet of guardrail
24 and anchors that has been removed, reset and accepted. Measurement will be made after the
25 guardrail has been reset.

26 *Remove and Reset Existing Guiderail* will be measured and paid in linear feet of guiderail and
27 anchors that has been removed, reset and accepted. Measurement will be made after the
28 guiderail has been reset.

29 Such price will include, but is not limited to, removing and resetting the guardrail, guiderail
30 and anchors and for furnishing all equipment, labor and incidentals necessary to complete the
31 work.

32 Payment will be made under:

Pay Item	Pay Unit
Remove and Reset Existing Guardrail	Linear Foot
Remove and Reset Existing Guiderail	Linear Foot

33 **SECTION 865**
34 **CABLE GUIDERAIL**

35 **865-1 DESCRIPTION**

36 Construct cable guiderail in accordance with the contract and at the locations designated in
37 the plans or as directed. Install additional double faced cable guiderail posts without cable at
38 median hazards as shown in *Roadway Standard Drawings*.

1 **865-2 MATERIALS**

2 Refer to Division 10.

Item	Section
Hardware	1046-4
Portland Cement Concrete, Class A	1000
Posts	1046-3
Precast Concrete Anchors	1077
Rail Elements	1046-2
Select Material, Class VI	1016

3 Manufacture cable in accordance with AASHTO M 30, Type I, Class A. The cable shall be
4 pre-inspected at the producer's facility before shipment.

5 Additional guiderail posts shall be double faced guiderail intermediate posts.

6 **865-3 CONSTRUCTION METHODS**

7 Erect the rail elements to produce a smooth continuous rail paralleling the line and grade of
8 the highway surface or as shown in the plans.

9 Posts may be power driven or set by hand. Protect the top of steel posts by a suitable driving
10 cap if power driven. If set by hand, dig post holes to the depth and at the locations shown in
11 the plans. Thoroughly ram the bottom of the post holes so that the posts will have a stable
12 foundation. Set the posts plumb and accurately space and align. Backfill the post holes in
13 6" layers with suitable material and thoroughly compact by tamping or puddling.

14 Where rock interferes with the proper installation of the post, excavate a shaft in the rock at
15 least 9" wide, parallel to the roadway, by 23" long, perpendicular to the roadway, and
16 24" deep. Place the post against the roadside edge of the shaft and fill in behind the post with
17 Class VI select material, up to the top elevation of the rock. Fill the remainder of the hole
18 with earth material. Where timber posts are to be driven in fill slopes 1.5:1 or steeper and the
19 fill height is 15 ft or more, auger a 6" diameter pilot hole to the full depth of the post before
20 driving.

21 When guiderail is being constructed near traffic, conduct operations to constitute the least
22 hazard to the public. Schedule and conduct operations to construct and complete each
23 individual continuous guiderail installation in the least possible time.

24 Do not begin work on any section of new guiderail until preparations are made to fully
25 complete the installation of the section as a continuous operation. Once work begins on
26 a section, pursue the work to its completion unless inclement weather or other conditions
27 beyond the control of the Contractor interfere with the work. Begin attachment of the cable
28 elements at the approach end of the guiderail and continue in the same direction as the
29 movement of traffic.

30 **865-4 MEASUREMENT AND PAYMENT**

31 *Cable Guiderail* will be measured and paid in linear feet of guiderail that has been
32 satisfactorily completed and accepted exclusive of that length of guiderail that is within the
33 pay limits of guiderail anchors. Measurement will be made from center to center of the
34 outermost post in the length of guiderail being measured. Such price will include, but is not
35 limited to, furnishing and erecting posts, cable, miscellaneous hardware, concrete, delineators
36 and all incidentals necessary to complete the work.

37 *Double Faced Cable Guiderail* will be measured and paid in linear feet of guiderail that has
38 been satisfactorily completed and accepted exclusive of that length of guiderail that is within
39 the pay limits of guiderail anchors. Measurement will be made from center to center of the
40 outermost post in the length of guiderail. Such price will include, but is not limited to,
41 furnishing and erecting posts, cable, miscellaneous hardware, concrete, delineators and all
42 incidentals necessary to complete the work.

Section 866

- 1 *Cable Guiderail Anchor Units* will be measured and paid in units of each completed and
- 2 accepted.
- 3 *Additional Guiderail Posts* will be measured and paid in units of each completed and
- 4 accepted.
- 5 No separate measurement will be made of any cable, posts, concrete, hardware or any other
- 6 components of the completed anchor units that are within the pay limits shown in the plans.
- 7 Payment will be made under:

Pay Item	Pay Unit
Cable Guiderail	Linear Foot
Double Faced Cable Guiderail	Linear Foot
Cable Guiderail Anchor Units	Each
Additional Guiderail Posts	Each

SECTION 866
FENCE

866-1 DESCRIPTION

Furnish and erect woven wire, chain link and barbed wire fence with gates in conformity with the details shown in the plans and at locations as shown in the plans.

866-2 MATERIALS

Refer to Division 10.

Item	Section
Barbed Wire	1050-4
Chain Link Fabric	1050-6
Fence Materials	1050-1
Fittings and Accessories	1050-7
Metal Posts and Rails	1050-3
Organic Zinc Repair Paint	1080-9
Timber Posts and Braces	1050-2
Woven Wire	1050-5

Use Class B concrete for anchors. Instead of Class B concrete, pre-mixed commercially bagged dry concrete mix may be used if the concrete meets the minimum strength requirements for Class B concrete when mixed with the quantity of water shown on the instructions printed on the bag.

866-3 CONSTRUCTION METHODS

(A) Clearing and Grubbing

Only clear the ground that is necessary to erect a clear fence line. Clearing includes satisfactory removal and disposal of all trees, brush, stumps, existing fence or other objectionable material. Erect the fence to conform to the general contour of the ground. Place the bottom of the fabric or wire no more than 6" above the natural ground, except where the Engineer directs that ditches and depressions are to be spanned by using extra length posts in conjunction with additional barbed wire installed between the bottom of the fence wire or fabric and the ground surface. Grade along the fence line to meet the above requirement such that no obstructions to proper drainage are created.

(B) Setting Posts and Braces

Set and maintain all posts in a vertical position. Line posts may be hand set or set with a post driver. Thoroughly tamp all backfilled material if hand set. If power driven, wood posts may be sharpened to a dull point. Remove and replace posts that are damaged by power driving.

Set posts in concrete anchors to maintain the position and alignment of the post when required in the plans or where dictated by soil conditions. Forms are not required for the concrete. Trowel the top of the concrete to a smooth finish and slope to drain away from the post. The concrete anchors require at least a 3 day curing period before any load is placed on the post.

Instead of setting roll formed steel line posts in concrete, such posts may be driven provided they are not part of a line brace assembly. Drive the posts at least 3 ft into the ground. Provide adequate protection to the post tops to prevent damage from the driving operations. Repair damage to the zinc coating in accordance with Article 1076-7. Set posts in concrete anchors where soil conditions are such that the posts cannot be driven without deformation, or where soils are encountered that does not provide adequate in-ground stability.

Where rock or concrete pavement or slabs are encountered within the required depth where fence posts are to be erected, drill a hole in the rock or concrete of a diameter slightly larger than the largest dimension of the post in the rock or concrete and grout in the post. The depth of post embedment shown in the plans will not be required and the post may be shortened as necessary, provided the post is embedded within the rock or concrete pavement or slab to a minimum depth of 12".

Do not fabricate extra length posts by welding short sections of posts together.

Place line braces at the end of each roll or piece of woven wire.

Do not use pieces of woven wire fabric less than 100 ft in length, unless otherwise directed. When the use of short pieces of woven wire is permitted, furnish and install the additional required brace posts and braces. Approved splicing sleeves may be used instead of providing such brace posts and braces.

Set approved sleeves in retaining wall in accordance with the details in the plans. After the posts have been set, fill sleeves with grout.

(C) Installing Fabric and Wire**(1) Chain Link Fence**

Attach chain link fabric to tubular end, gate, corner or brace posts with stretcher bars and stretcher bar bands as shown in the plan. Fasten the fabric to line posts and to top and brace rails with wire fasteners spaced and wound as shown in the plans. Fasten the fabric to the tension wire by hog rings spaced at 24" intervals or weave the tension wire through the fabric. Make hog ring ties at fabric joints with the hog ring passing completely around the fabric joint.

Place chain link fabric by securing or fastening on end and applying sufficient tension to remove all slack before making permanent attachments elsewhere. Apply the tension for stretching by mechanical fence stretchers designed for this purpose.

Connect rolls and pieces of chain link fabric to each other by field weaving provided that such weaving is identical in appearance and strength as the machine weaving done at the factory.

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1 Attach barbed wire used in conjunction with chain link fabric, to the post by eyebolt
2 or by a tie wire passing through holes drilled in the metal post to prevent any vertical
3 movement of the barbed wire. Wrap the ends and beginnings of strands around the
4 post twice and securely fasten by winding the end around the wire near the post.
5 Splice barbed wire only at posts.

6 Install additional barbed wire when shown in the plans or where directed.

7 (2) Woven Wire Fence

8 Stretch woven wire fabric taut and securely attach to each post with one or more
9 staples in each line of wire. Use as many staples as required to firmly secure the
10 wire at the location and elevation required by the plans. When woven wire is
11 attached to metal posts, use at least 5 clips at each post to fasten the individual
12 strands of wire to the post except where wrapping of the strand around the post is
13 required. Stretch with an approved stretcher that will produce equal tension in each
14 line of wire.

15 At each end or gate post, at the center post in each line brace and at corner posts
16 except as otherwise shown in the plans, cut out all vertical strands of wire and wrap
17 each horizontal strand of wire around the post and securely fasten by winding the
18 end around the strand of wire near the post.

19 Do not splice fabric between the posts of a brace post assembly. Do not splice
20 between other posts, unless the splicing sleeves are approved.

21 Pull woven wire taut and securely attach to each post by methods described for
22 woven wire when used in conjunction with woven wire fabric. Do not splice woven
23 wire between posts.

24 Install additional woven wire as shown in the plans or where directed.

25 (3) Barbed Wire Fence

26 Install barbed wire fence in accordance with the plans and as directed.

27 Pull barbed wire taut and securely attach to each post by methods described for
28 woven wire. Do not splice barbed wire between posts.

29 **866-4 MEASUREMENT AND PAYMENT**

30 *Woven Wire Fence*, ___" Fabric will be measured and paid in linear feet of fence, measured in
31 place from center of each post or gate post to center of end post or gate post exclusive of gate
32 sections, that has been completed and accepted.

33 *Chain Link Fence*, ___" Fabric will be measured and paid in linear feet, of fence measured in
34 place from center of each post or gate post to center of end post or gate post exclusive of gate
35 sections, that has been completed and accepted.

36 ___ *Strand Barbed Wire Fence with Posts* will be measured and paid in linear feet of fence
37 measured in place from center of each post or gate post to center of end post or gate post
38 exclusive of gate sections, that has been completed and accepted. All posts used for the
39 barbed wire fence are included in the price of the barbed wire fence and will not be paid
40 separately.

1 ___" *Timber Fence Posts*, ____ will be measured and paid in units of each for the several sizes
2 and kinds of posts installed on the project, including timber line posts, brace posts, gate posts
3 and posts erected as barriers at driveways and entrances. The actual length of timber posts in
4 linear feet of variable length and extra length posts shall be measured as placed and converted
5 to an equivalent number of standard length posts of the same size for which a pay item has
6 been established. In converting to equivalent numbers of standard length posts, any fractional
7 portion of a post remaining from the division of a total number of linear feet by a standard
8 post length shall be considered as equal to one post. Where the Contractor has elected to use
9 pieces of woven wire shorter than 100 ft in length, as permitted by Subarticle 866-3(B), on the
10 condition that he furnish and install at no additional cost to the Department line braces at the
11 ends of short pieces, timber fence posts shall include the number of line posts made
12 unnecessary by such line braces but shall exclude the posts used in the line braces.

13 *Metal Line Posts for ___" Chain Link Fence* will be measured and paid in units of each for the
14 several sizes and kinds of posts actually installed on the project. For extra length metal posts,
15 the actual length of post in place in excess of the standard pay length for each post shall be
16 measured in linear feet, and half of such length shall be converted to an equivalent number of
17 standard length posts of the same size for which a pay item has been established. In
18 converting to equivalent numbers of standard length posts, any fractional portion of a post
19 remaining from the division of a total number of linear feet by a standard post length shall be
20 considered as equal to one post.

21 *Metal Terminal Posts for ___" Chain Link Fence* will be measured and paid in units of each for
22 all end, corner and brace posts installed on the project.

23 *Metal Gate Posts for ___" Chain Link Fence, Double Gate* will be measured and paid in units
24 of each for gateposts installed on the project.

25 *Metal Gate Posts for ___" Chain Link Fence, Single Gate* will be measured and paid in units of
26 each for gate posts installed on the project.

27 *Double Gates, ___High, ___Wide, ___ Opening* will be measured and paid in units of each for the
28 number of gates actually erected on the project. Double gates will be measured as one gate.

29 *Single Gates, ___ High, ___Wide, ___ Opening* will be measured and paid in units of each for the
30 number of gates actually erected on the project.

31 *Additional Barbed Wire* will be measured and paid in linear feet of wire installed in the work,
32 complete and in place. Measurement of additional barbed wire will be made along each
33 strand after the installation has been completed. No measurement will be made of any wraps,
34 nor will measurement be made of the upper or lower continuous strand of barbed wire that is
35 erected as part of woven wire fence.

36 Setting sleeves in retaining wall will not be paid as such work is incidental to the other pay
37 items in this specification.

38 Work includes, but is not limited to, clearing and grading; and furnishing and installing fence
39 fabric, barbed wire, staples, tie wires, stretcher bars, top rails, tension wire, posts and post
40 braces, concrete, gates, fittings and any other materials, furnishing and installing sleeves in
41 retaining walls and filling sleeves upon setting posts.

42 When the use of short pieces of woven wire is permitted, furnish and install the additional
43 required brace posts and braces at no additional cost to the Department.

Section 867

1 Payment will be made under:

Pay Item	Pay Unit
Woven Wire Fence, ___" Fabric	Linear Foot
Chain Link Fence, ___" Fabric	Linear Foot
___ Strand Barbed Wire Fence with Posts	Linear Foot
___" Timber Fence Posts, ___' Long	Each
Metal Line Posts for ___" Chain Link Fence	Each
Metal Terminal Posts for ___" Chain Link Fence	Each
Metal Gate Posts for ___" Chain Link Fence, Double Gate	Each
Metal Gate Posts for ___" Chain Link Fence, Single Gate	Each
Double Gates, ___ High, ___ Wide, ___ Opening	Each
Single Gates, ___ High, ___ Wide, ___ Opening	Each
Additional Barbed Wire	Linear Foot

2 **SECTION 867**
3 **FENCE RESET**

4 **867-1 DESCRIPTION**

5 Remove and reset existing fences of various types to the locations indicated in the plans or
6 where directed.

7 **867-2 CONSTRUCTION METHODS**

8 Reset the fence in a condition that is equal to or better than before the fence is removed.
9 Replace any of the fence components unnecessarily damaged by the Contractor's forces. Fill
10 any void created by fence removal.

11 The Contractor will be responsible for damage caused by livestock escaping or entering the
12 existing fenced area through the negligence of his forces.

13 If the owner of the fence desires to repair, rebuild or renew any parts of the fence and agrees
14 to furnish the materials without cost to the Contractor, then repair, rebuild, renew and reset
15 such fence using the material furnished by the owner at no additional cost to the owner or the
16 Department.

17 **867-3 MEASUREMENT AND PAYMENT**

18 ___ *Fence Reset* will be measured and paid in the linear feet of fence that has been
19 acceptably reset. Measurement will be made along the fence after it has been reset from
20 center of end post to center of end post. Such price includes, but is not limited to, removing,
21 hauling and re-erecting the existing fence; and furnishing and installing any fence components
22 unnecessarily damaged by the Contractor's forces.

23 Payment will be made under:

Pay Item	Pay Unit
___ Fence Reset	Linear Foot

24 **SECTION 869**
25 **RELAPPING GUARDRAIL**

26 **869-1 DESCRIPTION**

27 Relap either existing or recently installed guardrail in accordance with the contract and where
28 directed.

Section 876

1 **876-4 MEASUREMENT AND PAYMENT**

2 *Rip Rap, Class ____* will be measured and paid in tons. Plain rip rap will be measured by
3 weighing rip rap in trucks in accordance with 106-7.

4 *Geotextile for Drainage* will be measured and paid in square yards. Filtration geotextiles will
5 be measured along the ground surface as the square yards of exposed geotextiles before
6 placing rip rap. No measurement will be made for overlapping geotextiles.

7 The contract unit prices for *Rip Rap, Class ____* and *Geotextile for Drainage* will be full
8 compensation for providing, transporting and placing rip rap, filtration geotextiles, wire
9 staples and anchor pins.

10 Payment will be made under:

Pay Item

Rip Rap, Class ____
Geotextile for Drainage

Pay Unit

Ton
Square Yard

DIVISION 9 SIGNING

SECTION 900 GENERAL REQUIREMENTS FOR SIGNING

900-1 DESCRIPTION

Furnish, fabricate and erect complete traffic sign systems in accordance with the contract.

900-2 ACCEPTANCE OF SIGNS

Before final inspection of the signs, clean exposed sign and support surfaces and repair the site as may be deemed necessary to ensure the safety, effectiveness and neat appearance of the work.

Maintain responsibility for the signs until accepted. Any damaged sign will not be accepted. Any repairs to the signs before final acceptance of the project are to be approved.

Do not perform any repair work without written approval. Make repairs only in the presence of the Engineer.

Handle, transport and store all signs in accordance with the sheeting manufacturer's recommendations. Failure to comply with the manufacturer's recommendations during the handling, transporting and storing of the signs will be cause for rejection.

The Contractor may request early Department acceptance of part or all of the highway signs, including sign panels, retroreflective sheeting and associated hardware, before final project acceptance. Sign supports will not be accepted early. To be accepted before final project acceptance, the signs shall be required for traffic control at that phase of project construction.

If the Department accepts the signs, the Contractor will be relieved of the responsibility for any damage or theft that may occur to the signs, retroreflective sheeting or associated hardware, with exception of any damage caused by the Contractor or any subcontractor working on the project.

900-3 ALTERNATE DESIGN

Standard designs for Types A, B, C, D, E or F signs will be shown in the contract. Instead of the standard design, the Contractor may submit for approval an alternate design for sign panels differing in component parts and construction details from those shown in the contract. Provide any alternate designs that are in accordance with the MUTCD.

Submit complete details of the alternate sign designs to the Engineer for approval. Include the dimensions, thickness and alloys of the component parts, and typical shop drawings of all fabrication, erection and construction details.

Alternate design for supports and footings will not be permitted.

900-4 COVERING OF SIGNS

Cover signs or portions of signs with opaque material if erected on roads open to traffic and not yet applicable. Keep signs or portions of signs covered until instructed to remove the covering. Provide covering for entire signs by an approved method provided by sheeting manufacturer that will prevent the messages from being read or seen during both day and night conditions and that will cause no harm to the sheeting face.

Section 901

**SECTION 901
SIGN FABRICATION**

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901-1 DESCRIPTION

Fabricate and furnish signs, including sign face, supporting frames, hardware and package the signs for shipment.

901-2 MATERIALS

Refer to Division 10.

Item	Section
Retroreflective Sheeting	1092-2
Signs and Hardware	1092-1

901-3 CONSTRUCTION METHODS

(A) General

Details concerning the fabrication and erection of the signs are shown in the contract. Sign designs not shown in the contract are available from the Engineer.

Fabricate all items within 1/8" of design measurements. Scribe each sign, shield, arrow, overlay or blank on the back with the month and year.

Do not begin fabrication of Type A, B and C signs until S-dimension verification revisions have been approved.

Provide mounting holes in the Z-stringers of the signs in accordance with the details shown in the contract or approved shop drawings. Provide a space between the Z-bar and backing strip not greater than 1/8".

Date the erection of all signs and sign assemblies using printed self-adhesive stickers designed for punching the appropriate day, month and year numbers with a hole punch. Place the sticker on the back of each sign in the lower corner nearest the roadway. The Sign Fabricator will provide a sufficient quantity of the stickers for each sign. Print on the back of each sign the size of that sign [e.g. 144" x 48"] with a black permanent marker with numbers at least 2" in height and located near the self-adhesive sticker.

Ship all multi-panel signs to the project intact, completely assembled and ready to be installed. Fabricate signs taller than 12 ft as 2 separate signs with a horizontal splice, ready to be spliced and installed. No assembly other than a horizontal splice will be permitted except when a route shield or copy is required to be attached because of the horizontal splice.

(B) Department and Contractor Furnished Signs

Use the contract to determine whether the signs are to be fabricated and furnished by the Contractor or whether the Department will provide them to the Contractor.

For both Department and Contractor Furnished Signs, the Contractor provides all mounting hardware consisting of, but not limited to, shims, backing plates, mounting bolts, washers and nuts.

The sign fabricator will provide vertical Z-bars required for attaching secondary signs to the primary signs.

Confirm in writing at least 4 months in advance, the actual date the Department furnished signs will be required. The signs will be made available to the Contractor for pickup at the North Carolina Department of Correction sign fabrication facility on N.C. 39 near Bunn, North Carolina, unless otherwise indicated in the contract. Provide for all transportation.

The Engineer will inspect and approve the signs before they are packaged and crated for shipment. Take delivery of all signs within 60 days of the date requested or the date they are made available, whichever occurs last, and within 96 hours of receiving the first sign. The Engineer shall approve any exception to the above delivery procedure. At the time the signs are delivered to the project, provide to the Engineer one copy of the sales ticket furnished with the signs.

After taking possession of the signs, be responsible for any damage or theft that occurs to signs before final acceptance by the Engineer. Comply with the reflective sheeting manufacturer's recommendations for handling, transporting, erecting and storing of the signs. Acceptably repair or otherwise correct any damage to the signs or refabricate them. When requested by the Contractor, the Department may have the necessary repairs made or the signs refabricated, and deduct the associated cost thereof from monies due the Contractor.

(C) Signs

Construct all signs, supporting frames and assemblies in accordance with the details shown in the contract and Tables 901-1 and 901-2.

Sign Type	Vertical and Horizontal Dimensions	144" x 48" Aluminum Panels	Horizontal Z-Bars	Aluminum Thickness
A	Vertical or Horizontal > 144" or Vertical and Horizontal > 48"	Multiple	Yes	0.125"
B	Vertical and Horizontal < 144" and Vertical or Horizontal < 48"	Single	Yes	0.125"
C	-	Single, Dual	Yes	0.125"
D	-	Single	No	See Table 901-2
E	-	Single	No	See Table 901-2
F	-	Single	No	See Table 901-2

(1) Type A Signs

Fabricate Type A signs from multiple aluminum sheet increments of the thickness shown in Table 901-1, with welded studs for attachment to the supporting frame.

Use aluminum sheets with increments of 4 ft in width; except, for sign widths that are not multiples of 4 ft, a maximum of 2 panels may be cut to less than 4 ft. No panel may be cut to less than one foot. Mount aluminum sheet increments vertically and provide with backing strips at the vertical joints, held firmly in place, to keep the abutting sheets in proper alignment. Leave a space of 0.020" to 0.032" between each panel sheeted with non-prismatic sheeting. Prismatic sheeting is to be trimmed at a 45° angle from the edge of each panel.

Fabricate signs with a height of 12 ft or less, without horizontal joints. One horizontal joint will be permitted for signs that are more than 12 ft in height. Locate the joint near the mid-height of the sign. Construct this joint according to the details in accordance with the contract.

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- 1 (2) Types B and C Signs
2 Fabricate Types B and C signs from multiple aluminum sheet increments of the
3 thickness shown in Table 901-1, with welded studs for attachment to the supporting
4 frame.
- 5 (3) Types D, E and F Signs and Milemarkers
6 Fabricate Types D, E and F signs and milemarkers from single sheets of the
7 thickness shown in Table 901-2, with holes for bolting to the supports.
- 8 Construct Types E and F signs in accordance with the *FHWA Standard Highway*
9 *Signs*. Apply the retroreflective sheeting to the separate signs in all
10 Types E and F sign assemblies consecutively to provide correct color matching on
11 each completed assembly. Adequately identify each individual sign to the correct
12 assembly. Following the erection of Type E and F sign assemblies, leave the
13 identification markings on the individual signs until Department personnel have
14 verified compliance with these requirements.
- 15 (4) Overlays for Existing Signs
16 Manufacture all overlays for existing signs of the thickness shown in Table 901-2.
17 Do not make holes for rivets in the overlays during fabrication, but instead field-drill
18 them during the erection process.

(D) Aluminum

- 20 (1) Thickness Requirements

Vertical or Horizontal Dimension	Minimum Thickness
<i>Inches</i>	<i>Inches</i>
0-11.9	0.032
12-35.9	0.063
36-47.9	0.080
48 and larger	0.125
Milemarkers	0.080
Overlays	0.063

- 21 (2) Preparation of Aluminum Sign Surfaces
22 Do not handle any metal, except by appropriate handling devices or by workmen
23 wearing clean gloves, between the beginning of the coating operations and the
24 completion of the application of the retroreflective sheeting. Retreat aluminum sign
25 surfaces that come into contact with grease, oils or other contaminants before the
26 application of retroreflective sheeting.
- 27 Before applying retroreflective sheeting to the aluminum, treat the aluminum sign
28 surfaces with a chromate conversion coating. Such coating shall be applied
29 according to the manufacturer's instruction and shall conform to ASTM B449,
30 Class 2, and should range in color from silvery iridescent to pale yellow. The
31 coating weight shall be 10 mg/sf to 35 mg/sf on the entire surface area including
32 along the edges of the sign substrate with a median of 25 mg/sf as the optimum
33 coating weight. Ensure the coating does not appear dusty when wiped with a clean,
34 lint-free cloth and does not show excessive buildup at edges. Sand smooth all burrs
35 and scratches before applying retroreflective sheeting. Sheet all sanded aluminum
36 within the same day to prevent the formation of corrosion on the metal. Do not sand
37 or use abrasive materials on sheeted faces. Aluminum products shall be randomly
38 tested.

(E) Supporting Frames

Use supporting frames for Types A and B signs consisting of 2 or more horizontal aluminum Z-stringers with vertical aluminum bar stiffeners in accordance with the details and dimensions shown in the contract. Use a nylon washer to attach all thru bolts with a play of at least 1/16" and no more than 1/8". Provide stringers with necessary holes and slots for bolting stiffeners, attaching aluminum sheet increments and mounting to supports. Do not field drill holes in any part of the structural assembly, except the field drilling of horizontal Z-bars for attaching new signs to existing supports when necessary.

(F) Welding

Weld studs to aluminum sheets by the capacitor discharge method. If the studs are welded after the retroreflective sheeting has been applied, insure that burn-through does not damage the retroreflective sheeting.

Shoot a test stud on each Type A, B and C sign in the lower left corner of the most left panel facing the back of the sign.

(G) Retroreflective Sheeting

Apply retroreflective sheeting to the aluminum sign panels in accordance with the retroreflective sheeting manufacturer's recommendations. For each multi-panel increment sign using glass beaded materials, sheet the entire sign from the same roll.

If a sign panel needs to be replaced after sign fabrication, the replacement panel may be sheeted with retroreflective materials from a different lot or drum number than the remainder of the sign; however, use material that visually color matches and meets Article 1092-2.

Take retroreflectometer readings on all 4 corners of each panel and document the readings on the sign design drawings.

Overlap all splices of any encapsulated or enclosed lens sheeting to allow water to run off without running into the splice.

Remove all foreign materials on the sheeted face with compressed air.

Keep a sample of each roll of sheeting and test for retroreflective compliance.

Patch wrinkles in the sheeting around thru bolts by removing the affected sheeting from the metal. Then patch this area with a circular patch encompassing an area 1/4" outside the affected area. This patch shall not exceed the standard patching limits shown in Table 901-3.

Ensure that all patches on the sign have a 1" minimum width or as recommended by the sheeting manufacturer.

Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted and metal treater on all signs, slip sheeting, copy, borders, shields, overlays, arrows and panels and retroreflectometer readings.

Obtain and assign to the Department in writing warranties for sign sheeting used in the fabrication of all permanent signs from the sheeting manufacturer. Warrant the signs against defective sheeting per the requirements outlined in the contract.

Define "permanent signs" as Types A, B, C, D, E and F signs, overlays for all sign types and milemarkers, and exclude any signs used only for traffic control while the project is under construction.

The reflective sheeting may be patched to repair incidental damage to the sheeting that might occur during manufacture, in transit or after installation; however, the patches cannot exceed the limits in Table 901-3.

Section 901

**TABLE 901-3
SIGN PATCHING LIMITS**

Sign Area	Maximum Number and Size of Patches During Fabrication		Maximum Number and Size of Additional Patches After Field Erection	
	Max. Number per Sign	Max. Size in Sq.In.	Max. Number per sign	Max. Patch Size in Sq.In.
0 to 15.0	0	0	0	0
15.1 to 50.0 (Single Panel)	1	1	1	1
30.0 to 80.0 (Increment Panel)	2	2	1	2
80.1 and Greater	A	3	A	3

A. Average not to exceed one patch per panel per sign. Maximum of 3 patches per panel allowed during fabrication with one additional patch per panel allowed after field erection.

(H) Reflectorized Letters, Numerals, Symbols, Border and Shields

(1) General

Use direct-applied retroreflective sheeting or demountable retroreflective sheeting letters, numerals, borders, shields and arrows as indicated on the sign designs.

Use designs of letters and numerals that conform to the *FHWA Standard Highway Signs*. Use border widths, design of route shields and arrows that conform to the MUTCD.

Route shields used on Type A or B signs or overlays shall be demountable.

Space and size all legends and borders in accordance with the contract or approved shop drawings. Any loose, deformed or misplaced legends and borders will be cause for rejection of the entire sign.

(2) Direct Applied

Provide direct-applied reflectorized letters, numerals, arrows and borders that are of the type and color of retroreflective sheeting shown in the contract for each sign. All direct applied copy or border not permanently affixed may be removed and replaced on signs if necessary during manufacture.

(3) Demountable

Attach demountable letters, numerals, borders, shields, arrows and alphabet accessories directly to sign faces with rivets as shown in the contract.

Use letters, numerals, arrows, borders and shields made of adhesive-coated retroreflective sheeting, permanently adhered to a flat aluminum backing, in accordance with the contract.

Use aluminum backing of at least .032" thick aluminum sheeting of 3004 H38, 5052 H38 or 6061 T6 alloy. Treat with a light, tight, amorphous chromate-type coating in accordance with the recommendations of the retroreflective sheeting manufacturer. Apply the retroreflective sheeting to the properly prepared aluminum using the method and equipment prescribed by the sheeting manufacturer.

1 Supply each letter, numeral, arrow, border and shield with mounting holes, and
2 secure to the sign surface with non-twist corrosion resistant aluminum rivets. Use
3 letters, numerals, arrows and borders that have rivets on all sides and ends spaced not
4 more than 6" on centers, measured along the edges. Make sure that each legend
5 piece has at least one rivet in each corner and at least 2 rivets in each end. Attach
6 route shields as part of Type A or B signs with aluminum rivets spaced not more
7 than 9" apart, measured along the edges of the shield.

8 Use a 1/4" diameter nylon washer under the head of all pull through type rivets for
9 all demountable copy and shields.

10 **(I) Silk Screening**

11 Apply all legends and borders on Type E and F signs by silk-screening or reverse
12 silk-screening after the sheeting is attached to the panels. Perform all screening as
13 recommended by the manufacturer of the retroreflective sheeting. Use the color of all
14 legends, borders and backgrounds, and their placement on the sign, in accordance with
15 the contract.

16 Use opaque black ink for nonreflectorized message application, as manufactured or
17 recommended by the manufacturer of the retroreflective sheeting.

18 Use transparent ink and thinner, for application on signs reflectorized with white
19 retroreflective sheeting, as manufactured or recommended by the manufacturer of the
20 retroreflective sheeting. Use colors that conform to the *FHWA Color Tolerance Charts*
21 and AASHTO M 268 when thoroughly dry.

22 Test all lots of transparent ink for compliance with the minimum coefficient of
23 retroreflection equal to 70% of the specified minimum retroreflection of the
24 corresponding sheeting color and document the retroreflection value.

25 Inspect the first 5 signs of each screening and then every fifth sign. When unacceptable
26 signs are found, all signs shall be inspected individually.

27 Only 3 nonwets per square foot, no larger than 1/16" in diameter, covering no more than
28 1/3 of the total area of the sign are allowable. This includes nonwets from either the
29 sheeting or the screen-printing.

30 Only one tadpole per 6 sf, no longer than 1 1/2" and not readily visible under lighted
31 inspection is allowable.

32 **(J) Mounting Hardware**

33 Provide all mounting hardware consisting of, but not limited to, shims, backing plates,
34 mounting bolts, washers and nuts. Provide mounting holes in the Z-stringers of the
35 ground mounted signs in accordance with the details shown in the contract.

36 **(K) Packaging, Shipping and Storing**

37 Protect all signs during shipment and storage. Before shipping, make sure that all signs
38 are free of moisture and that all inks are thoroughly dry. Do not apply adhesive tapes to
39 any sign surface. Keep all packaged signs entirely dry.

40 Use assembled or partially assembled signs other than flat sheet signs that have sufficient
41 braces securely attached to prevent buckling or warping at all times.

42 Affix a label outlining the retroreflective sheeting manufacturer's recommendations for
43 handling, transporting and storing all types of signs to each shipping carton or crate.
44 Provide full details of such recommendations with each shipment of signs.

45 Label each crate or package of signs or panels as to the contents (arrows, shields, etc.),
46 WBS number and sequence of packages if more than one package is for a single sign.

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- 1 Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted,
2 metal treater on all signs, slipsheeting, copy, borders, shields, overlays, arrows, panels
3 and retroreflectometer readings.
- 4 Individually rack or separate by foam or slip sheeting on A-frame racks all sheeted
5 panels. Do not use spliced, overlapped, ripped or torn slipsheeting or foam.
- 6 Store all packed signs standing at a 75° to 90° angle.
- 7 Turn all panels and sign faces to the inside of the crates, whenever possible.
- 8 When crating a one-panel sign, provide the face side with an extra piece of foam and
9 cardboard taped to the outside of the face side of the package.
- 10 Pack panels of 102" in length or longer in only 2 per package.
- 11 Ensure all signs are debris free on the back side, with no misplaced writing, tape or
12 extraneous sheeting.
- 13 Crate to allow a 2" space on the inside dimensions larger than the size of the largest
14 package.
- 15 Store completed Type A and B signs back to back with at least 12" between faces.
- 16 When crating 2 panels of different sizes, place the smaller panel with its face to the back
17 of the larger panel and package with an extra piece of foam and cardboard taped to the
18 outside of the larger panel, with its face to the outside of the crate. Provide extra
19 packaging on both outsides of the package for double-faced signs.
- 20 Crate packaged panels to allow the passage of a 1/8" spacer on the inside of each side of
21 the crate, so that the panels are not overly tight or binding in crate.
- 22 Inspect all signs and packaging before shipping to assure compliance with the contract
23 and the *Standard Specifications*. The Department retains the right to inspect the signs
24 and packaging before shipping.

25 (L) Transparent Films

- 26 Use transparent films instead of silk screening when authorized by the Department.
27 Transparent film is a durable, transparent, acrylic colored film coated with transparent,
28 pressure-sensitive adhesive. When the film is applied over reflective sheeting, the
29 coefficient of retroreflectivity shall meet the color and type of sheeting in Tables 1092-3,
30 1092-4 and 1092-5. Use Department approved transparent film approved by the
31 manufacturer of the reflective sheeting to insure the materials meet the manufacturer's
32 warranty and obligation in Subarticle 1092-2(B).

33 901-4 SIGN QUALITY

- 34 Provide signs that present a uniform appearance free from color match problems, non-uniform
35 color, streaks, spots, abrasions, blistering or other defects in the sheeting.
- 36 Sheeting may be inspected before application to sign blanks, after installation to sign blanks,
37 after completion of the sign in the sign fabricator's facility and after installation. Clean all
38 installed signs before final field inspection.

1 The retroreflective sheeting will be unsatisfactory if it has deteriorated due to any cause
 2 except defacement resulting from vandalism or damage resulting from impact by a motor
 3 vehicle or other object to the extent that:

4 (A) The sign is ineffective for its intended purpose when viewed from a moving vehicle
 5 under normal day and night driving conditions, or

6 (B) The coefficient of retroreflection is less than the minimum specified for that sheeting as
 7 shown in Tables 1092-3, 1092-4 and 1092-5 when measured by a Department approved
 8 retroreflectometer, or

9 (C) The screened message and border or reverse screened background has stained,
 10 discolored, streaked, faded, turned dark or has developed cracks, scaling, pitting and/or
 11 blistering, or

12 (D) The sign is unsatisfactory with regard to uniform appearance due to cracking, streaking,
 13 delamination, blistering, crazing or discoloration of the sheeting, or

14 (E) The sign is unsatisfactory with regard to remaining uniform in color over the entire
 15 reflecting surface both day and night and displaying the same color both in daylight and
 16 under lights at night.

17 (1) For glass bead material, sheeting will be subjected to a visual test with the human
 18 eye as the test instrument. Objectionable non-uniformity of color and reflectivity
 19 (retroreflection) under light at night is cause for the sign to be tested for
 20 retroreflection to determine compliance with the following requirements:

21 The retroreflection values on any sign shall not vary from each other by more than
 22 a ratio of 1.10 (1.20 white) at any 2 points at least 12" apart, nor more than
 23 1.30 (1.30 white) at any 2 points anywhere on the sign, nor more than,
 24 1.10 (1.20 white) at any 2 points on the border or between any 2 adjacent letters,
 25 numerals or symbols. Failure to meet the above requirements will result in sign
 26 rejection. Retroreflection will be tested using a Delta RetroSign retroreflectometer.

27 (2) For prismatic material, sheeting will be subjected to a visual test with the human eye
 28 as the test instrument.

29 **901-5 MEASUREMENT AND PAYMENT**

30 Sign fabrication will be measured and paid as the actual number of square feet of sign face
 31 areas of each type, including milemarkers and overlays acceptably fabricated. In measuring
 32 this quantity, the sign face areas will be calculated to the nearest 1/100 of a square foot, using
 33 the dimensions shown in the contract.

34 The areas of odd-shaped signs (e.g. stop signs and shield-shaped route markers) will be
 35 calculated as squares or rectangles using the dimensions shown in the contract. The areas of
 36 round, diamond and triangular signs will be calculated for their true shapes using plan
 37 dimensions.

38 Repair or otherwise correct any damage to the signs or refabricate them at no cost to the
 39 Department. When requested by the Contractor, the Department may have the necessary
 40 repairs made or the signs refabricated, and deduct the associated costs thereof from monies
 41 due the Contractor.

42 Payment will be made under:

Pay Item

Contractor Furnished, Type ____ Sign
 Department Furnished, Type ____ Sign

Pay Unit

Square Foot
 Square Foot

Section 902

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**SECTION 902
FOUNDATIONS FOR GROUND MOUNTED SIGNS**

902-1 DESCRIPTION

Construct foundations for sign supports including locating, staking, excavating, shoring, backfilling, forming, landscaping and other necessary tasks as required.

902-2 MATERIALS

Refer to Division 10.

Item	Section
Joint Sealer	1028-2
Organic Non-Aerosol Zinc Repair Paint	1080-9
Portland Cement Concrete Production and Delivery	1000
Reinforcing Steel	1070
Select Material and Borrow Material	1016 and 1018

902-3 CONSTRUCTION METHODS

Establish the proper offset, longitudinal location and foundation elevation of each ground mounted sign support. Provide proper level and orientation of all supports.

Thoroughly compact all backfill in 6" layers. Remove all unneeded excavated material from the site.

Perform all excavation necessary for foundation construction to the elevations and dimensions shown in the contract. Place concrete against undisturbed soil.

Construct concrete sign foundations in accordance with Section 825. Construct either reinforced or plain Class A concrete foundations in accordance with the contract. Shape the tops of the foundations to conform with finished ground elevations such that water will not collect against the supports. No construction joints will be permitted.

Form the top 6" of foundations by approved methods. Center the supports in the foundations, securely brace and hold in proper position and alignment during placement of the concrete. Provide an ordinary surface finish to the concrete.

902-4 MEASUREMENT AND PAYMENT

The quantity of reinforced and plain concrete to be paid will be the actual number of cubic yards of concrete incorporated into the completed and accepted foundation. Computing the number of cubic yards of concrete will be done from the dimensions shown in the contract or from revised dimensions authorized by the Engineer, calculated to the nearest 1/100 of a cubic yard.

Payment will be made under:

Pay Item	Pay Unit
Reinforced Concrete Sign Foundations	Cubic Yard
Plain Concrete Sign Foundations	Cubic Yard

**SECTION 903
GROUND MOUNTED SIGN SUPPORTS**

903-1 DESCRIPTION

Furnish, fabricate, clear for sight distance and install ground mounted and barrier mounted signs supports.

1 The types of supports covered by this section are:

2 (A) Breakaway steel beam sign supports

3 (B) Simple steel beam sign supports

4 (C) 3-lb steel U-channel supports

5 (D) 2-lb steel U-channel supports

6 (E) Barrier sign support assembly

7 (F) Wood supports

8 (G) Steel square tube supports

9 **903-2 MATERIALS**

10 Refer to Division 10.

Item	Section
Breakaway or Simple Steel Beam Sign Supports (W- or S-Shapes)	1094-1(A)
Ground Mounted Signs	1094
Joint Sealer	1028-2
Organic Non-Aerosol Zinc Repair Paint	1080-9
Signing Materials	1092
Steel Square Tube Supports	1094-1
Steel U-Channel Supports	1094-1

11 **903-3 CONSTRUCTION METHODS**

12 **(A) Location and Field Verification**

13 The support lengths and dimensions for steel and wood ground mounted supports shown
14 in the contract are estimated for project bid purposes.

15 The Engineer or contract surveyor will establish the proper offset, longitudinal location;
16 foundation elevation and S-dimension of each ground mounted and barrier mounted sign
17 support. The Signing and Delineation Unit will issue a revision of the Sign Support
18 Chart Sheet following receipt of field-verified S-dimensions.

19 Order supports for ground mounted signs when the revised support lengths, dimensions
20 and sizes have been determined and the appropriate plan revision is completed.

21 Provide the proper vertical plumb, level and orientation of all signs and supports.

22 **(B) Clearing for Sign Sight Distance**

23 Clear vegetation in front of signs where necessary to achieve proper sight distance to the
24 sign. The sight distance area includes the triangular region of land extending from the
25 edge of the travel lane 800 ft in advance of the sign to 4 ft beyond the furthest edge of the
26 sign from the travel lane. The Engineer will determine where clearing is required and the
27 amount of clearing at the sign locations. Perform the clearing in accordance with
28 Section 200.

29 **(C) Breakaway Steel Beam and Simple Steel Beam**

30 Fabricate and install the supports in accordance with the contract. Punch, cut or weld
31 supports before galvanizing. Galvanize each component part in accordance with
32 ASTM A123 before assembly. Provide supports that are uniformly straight to within
33 1/8" tolerance for pieces less than 20 ft in length and 1/4" tolerance for pieces over
34 20 ft in length.

Section 903

1 Cut the upper and middle sections of breakaway supports from the same member. Bolt
2 the hinge joint in the breakaway supports to ensure true alignment of the 2 sections.
3 After bolting of hinge connections make sure that the 2 sections are in the same position
4 relative to each other, as before being cut. Completely assemble breakaway supports
5 before erection.

6 Provide supports that are plumb. Do not shim the supports. Take adequate care during
7 erection of supports to prevent damage to the surface finish. Use 2 coats of an approved
8 organic non-aerosol zinc repair paint in touching up damaged areas on all galvanized
9 materials.

10 (D) Steel Supports

11 (1) General

12 Drive the supports to the required depth, being sure they are plumb. Drive the
13 supports by hand or by mechanical means. Protect the supports with an appropriate
14 driving cap. Concrete foundations are not required. In island applications, cored
15 holes shall be to the soil depth.

16 Replace any support that is bent, or otherwise damaged in driving.

17 Do not weld or cut supports in the field, except for the saw cutting of U-channel
18 support material for the frames and cross braces that may be required for
19 Types D, E and F signs with 2 or more supports.

20 Use 2 coats of an approved organic non-aerosol zinc repair paint in touching up the
21 tops of U-channel supports that may have been damaged in driving. Cut ends of
22 supports, frames, cross bracing and damaged areas on these and all other galvanized
23 materials.

24 Use supports of sufficient length to permit the appropriate sign mounting height.
25 Spliced supports are not permitted on new construction.

26 (2) U-Channel

27 Use 3-lb galvanized steel U-channel supports for Types D, E and F signs. Use
28 2-lb galvanized steel U-channel supports for milemarkers.

29 (3) Perforated Square Tubing

30 Use square tube supports in accordance with the contract.

31 (E) Barrier Supports

32 (1) Small

33 Attach brackets and U-channel supports to the median or shoulder barrier for the
34 erection of Type E or F signs or milemarkers in accordance with the contract.

35 (2) Large

36 Attach brackets, anchorage and pipe supports to the median or shoulder barrier for
37 the erection of Type E signs in accordance with the contract.

38 (F) Wood Supports

39 Use wood supports in accordance with the contract.

40 Replace any support that is damaged during erection.

41 Breakaway wood supports shall be drilled in accordance with the contract. All wood
42 supports larger than 4" x 4" that have not been drilled shall be behind guardrail.

1 **903-4 MEASUREMENT AND PAYMENT**

2 The supports, specified in these *Standard Specifications*, installed and accepted, will be
3 measured for payment as follows:

4 *Supports, Breakaway Steel Beam* and *Supports, Simple Steel Beam* will be measured and paid
5 as the actual number of pounds of structural steel installed and accepted. The computed
6 nominal weights shown in the final revised plans will be used in determining this quantity.
7 Measurement will not be made of the weight of nuts, bolts and washers that are part of the
8 sign support, as they will be incidental to the work.

9 *Supports, 3-lb Steel U-Channel* will be measured and paid as the actual number of linear feet
10 of 3-lb steel U-channel supports incorporated into the completed and accepted supports and
11 assemblies. Measurements of length will be made to the nearest 1/10 of a foot.

12 *Supports, 2-lb Steel U-Channel* will be measured and paid as the actual number of
13 2-lb steel U-channel support installed and accepted.

14 *Supports, Barrier (Small)* will be measured and paid as the actual number of small barrier
15 supports installed and accepted.

16 *Supports, Barrier (Large)* will be measured and paid as the actual number of large barrier
17 supports installed and accepted.

18 *Supports, Wood* will be measured and paid as the actual number of linear feet of wood support
19 incorporated into the completed and accepted supports. Measurements of length will be made
20 to the nearest 1/10 of a linear foot. The computed linear feet of sign supports, as indicated in
21 the final revised plans will be used in determining this quantity.

22 *Supports, Steel Square Tube* will be measured and paid as the actual number of linear feet of
23 steel square tube supports incorporated into the completed and accepted supports and
24 assemblies. Measurements of length will be made to the nearest 1/10 of a foot.

25 Payment will be made under:

Pay Item	Pay Unit
Supports, Breakaway Steel Beam	Pound
Supports, Simple Steel Beam	Pound
Supports, 3-lb Steel U-Channel	Linear Foot
Supports, 2-lb Steel U-Channel	Each
Supports, Barrier (Small)	Each
Supports, Barrier (Large)	Each
Supports, Wood	Linear Foot
Supports, Steel Square Tube	Linear Foot

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**SECTION 904
SIGN ERECTION**

27

28 **904-1 DESCRIPTION**

29 Erect existing and proposed ground mounted and overhead signs to existing and proposed
30 supports and furnish mounting hardware. Relocate existing signs in accordance with the
31 contract and Specifications.

Section 904

1 The types of signs covered by this section are as follows:

2 (A) Type A signs

3 (B) Type B signs

4 (C) Type C signs

5 (D) Type D signs

6 (E) Type E signs

7 (F) Type F signs

8 (G) Milemarkers

9 (H) Overlay signs

10 (I) Reposition signs

11 (J) Logo Trailblazer

12 (K) Logo to panel

13 (L) Relocation signs

14 904-2 MATERIALS

15 Refer to Division 10.

Item	Section
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Signing Materials	1092
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Organic Non-Aerosol Zinc Repair Paint	1080-9
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16 904-3 CONSTRUCTION METHODS

17 (A) General

18 Provide new mounting bolts, washers, hex nuts, backing plates and all hardware for signs
19 to be mounted on existing or proposed supports. Do not weld, cut or fabricate in any
20 manner in the field, except for as allowed under Section 903 and for the drilling of holes
21 for attaching demountable legends and borders that cannot be attached in the shop. Field
22 drill Z-bars for attaching signs to supports as required.

23 Use 2 coats of an organic non-aerosol zinc repair paint in touching up field-drilled holes
24 and damaged areas on all galvanized materials as covered under Section 903.

25 Make sure that the horizontal edges of signs are level and that the faces of signs are
26 vertical.

27 Refer to Sections 900 and 901 for requirements of care and handling of signs, final clean
28 up and covering of signs.

29 (B) Type A , B and C

30 (1) General

31 Attach the signs to supports in accordance with the contract or the approved shop
32 drawings. Make sure that the face of the sign is flat. Any appreciable buckling or
33 warping of the sign face will be cause for rejection of the entire sign.

34 (2) Ground Mounted

35 Erect ground mounted Type A, B and C secondary signs by the required method of
36 attachment shown in the contract. Affix these signs by bolting the horizontal
37 Z-stringers directly to the supports or by bolting vertical Z-bars to the horizontal
38 Z-stringers of the primary sign.

39 (3) Overheads

40 For new overhead supports, erect overhead secondary signs in accordance with the
41 approved shop drawings.

1 For existing overhead supports, design and furnish all new structural members and
 2 mounting hardware necessary to erect the new signs. Prepare and submit to the
 3 Engineer for approval complete shop drawings and design computations for the
 4 bracing and accessory hardware required to attach the sign to the existing overhead
 5 sign support. Prepare the design in accordance with *AASHTO Structural Supports for*
 6 *Highway Signs, Luminaires and Traffic Signals*. Upon request, the Engineer will
 7 provide the Contractor with copies of the shop drawings for existing overhead sign
 8 supports.

9 Attach a new sign above a designated existing overhead sign in accordance with the
 10 contract. Furnish all new structural members and mounting hardware necessary to
 11 erect the new sign.

12 **(C) Type D, E, F and Milemarkers**

13 Attach the signs to U-channel or perforated square tube supports

14 **(D) Overlay (Ground Mounted and Overhead)**

15 Attach overlays to designated existing ground mounted or overhead signs as required by
 16 the contract.

17 Remove and dispose of all conflicting demountable legends, borders and overlays before
 18 attaching new overlays. Employ any method of removal necessary, provided it does not
 19 damage the existing sign or the attached overlay. Perform such minor repairs to existing
 20 signs as necessary before the attachment of overlays to ensure a finished sign face that is
 21 completely flat.

22 Field-drill 5/32" holes in both the overlay and the existing sign simultaneously, according
 23 to the rivet spacing requirements shown in the contract. Attach the proposed overlays
 24 with 1/8" diameter aluminum rivets of the "pull-through" type. Exercise sufficient care
 25 in attaching the overlays to ensure that the finished sign face is completely flat and
 26 without any ripples and/or buckles.

27 **(E) Reposition Overhead Signs**

28 Reposition existing signs on existing overhead sign supports as required by the contract.
 29 Reposition associated lighting systems and secondary signs along with the signs.

30 When required, drill new holes in the existing vertical attachment members, in order to
 31 maintain a minimum clearance of 17 ft to the roadway surface at the new location on the
 32 structure. No other field drilling will be allowed.

33 Adjust and relocate conduit and junction boxes as required.

34 **(F) Logo Trailblazer**

35 All logos will be made available for pick up at the Division Traffic Services' sign shop.
 36 Erect logos on U-channel or perforated square tube supports in accordance with
 37 Type F sign details shown in the contract.

38 **(G) Logo to Panel**

39 All logos will be made available for pick up at the Division Traffic Services' sign shop.
 40 Attach logos to the mainline signs with ten 1/8" diameter rivets of the pull through type.
 41 Attach logos to the ramp signs with four 1/8" diameter rivets of the pull through type.
 42 Drill 5/32" holes in the background signs to match those in the logos for attaching the
 43 logos to the background signs. Place logos as shown on the contract.

Section 907

(H) Relocation (Ground Mounted) Signs

Maintain signs in good serviceable condition throughout the duration of the project. Repair any areas or materials within the project limits disturbed or damaged in performance of the work required under this section as directed by the Engineer at no cost to the Department.

Remove existing signs from their existing locations and relocate to their new location in accordance with the contract. Repair or replace signs damaged in relocating at no cost to the Department. Refer to Section 907 for disposal of sign components.

Erect signs and supports according to requirements of Sections 903 and 904. Immediately relocate all warning and regulatory signs to new locations. Relocate all other signs to new locations in no more than 12 hours.

904-4 MEASUREMENT AND PAYMENT

Sign Erections (Ground Mounted and Overhead) will be measured and paid as the actual number of ground mounted and overhead signs erected and accepted. Each type F sign assembly will be measured as one sign.

Sign Erection, Relocate Type ____ (Ground Mounted) will be measured and paid as the actual number of signs acceptably relocated. Secondary signs will be incidental work in conjunction with the primary sign. Sign assemblies consisting of more than one sign panel will be considered one sign.

Payment will be made under:

Pay Item	Pay Unit
Sign Erection, Type ____ (Overhead)	Each
Sign Erection, Type ____ (Ground Mounted)	Each
Sign Erection, Type ____	Each
Sign Erection, Milemarkers	Each
Sign Erection, Overlay (Overhead)	Each
Sign Erection, Overlay (Ground Mounted)	Each
Sign Erection, Reposition Overhead	Each
Sign Erection, Logo to Panel	Each
Sign Erection, Logo Trailblazer	Each
Sign Erection, Relocate Type ____ (Ground Mounted)	Each

SECTION 907

DISPOSAL AND STOCKPILING OF SIGNING COMPONENTS

907-1 DESCRIPTION

Properly dispose of or stockpile signing components.

907-2 CONSTRUCTION METHODS

(A) General

Repair any areas or materials within the project limits disturbed or damaged in performance of the work required under this section as directed by the Engineer.

(B) Removal

Do not remove existing signing components until required replacements have been erected and are available for use by traffic or are available for immediate replacement.

Remove signing components by methods that will not damage other portions of the project or facility. Repair any damage by methods satisfactory to the Engineer.

1 Cut and remove electrical conduit to at least 18" below finished ground elevation. Plug
2 or seal the ends of the cut conduit by methods approved by the Engineer.

3 Remove foundations, including any reinforced steel or anchor bolts, to a minimum depth
4 of 2 ft below the finished ground elevation unless otherwise indicated by the contract.

5 Promptly backfill and compact areas disturbed by removal of foundations with suitable
6 materials and match the finished ground elevation. Seed disturbed areas in accordance
7 with Section 1661.

8 **(C) Disposal**

9 All materials to be removed and disposed of will become the property of the Contractor.
10 Promptly transport the materials from the project after they have been removed unless
11 otherwise permitted by the Engineer.

12 Promptly dispose of the concrete, reinforcing steel and anchor bolts from the project.

13 **(D) Stockpile**

14 Before stockpiling, remove signs from supports. The Department maintains ownership of
15 all materials to be stockpiled. Transport and stockpile designated items to locations
16 approved by the Engineer. Sort and stockpile all materials neatly in stacks or storage
17 bins. Repair or replace materials damaged in removal or while in storage.

18 **907-3 MEASUREMENT AND PAYMENT**

19 *Disposal of ____ and Stockpile ____* will be measured and paid as the actual number of
20 signing components acceptably disposed or stockpiled. Removal is incidental to stockpiling
21 and disposal. Secondary signs will be incidental work in conjunction with the primary sign.
22 Sign assemblies consisting of more than one sign panel will be considered one sign.
23 Overhead sign systems include signs, supports, walkways and all electrical components. Sign
24 systems include signs, supports and foundations. Supports include any foundations.

25 Repair or replacement of any materials or areas within the project limits disturbed or damaged
26 in performance of the work required under this section will be at no cost to the Department.

Section 907

1 Payment will be made under:

Pay Item	Pay Unit
Disposal of Sign System, Overhead	Each
Disposal of Sign System, Steel Beam	Each
Disposal of Sign System, U-Channel	Each
Disposal of Sign System, Wood	Each
Disposal of Sign, A, B or C, (Ground Mounted)	Each
Disposal of Sign, A or B, (Overhead)	Each
Disposal of Sign, D, E or F	Each
Disposal of Sign, Milemarker	Each
Disposal of Sign, Overlay (Overhead)	Each
Disposal of Sign, Overlay (Ground Mounted)	Each
Disposal of Support, Overhead Structure	Each
Disposal of Support, Steel Beam	Each
Disposal of Support, U-Channel	Each
Disposal of Support, Wood	Each
Disposal of Lighting System	Each
Disposal of Lighting Fixtures	Each
Disposal of Walkway	Each
Stockpile Sign System, Overhead	Each
Stockpile Sign System, Steel Beam	Each
Stockpile Sign System, U-Channel	Each
Stockpile Sign System, Wood	Each
Stockpile Sign, A or B, (Overhead)	Each
Stockpile Sign, A, B or C, (Ground Mounted)	Each
Stockpile Sign, D, E or F	Each
Stockpile Sign, Milemarker	Each
Stockpile Support, Overhead Structure	Each
Stockpile Support, Steel Beam	Each
Stockpile Support, U-Channel	Each
Stockpile Support, Wood	Each
Stockpile Lighting System	Each
Stockpile Lighting Fixtures	Each
Stockpile Walkway	Each

DIVISION 10 MATERIALS

SECTION 1000 PORTLAND CEMENT CONCRETE PRODUCTION AND DELIVERY

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1000-1 DESCRIPTION

This section addresses Portland cement concrete to be used for pavement, structures and precast and incidental construction. Produce Portland cement concrete composed of Portland cement, fine and coarse aggregates, water and pozzolans (optional). Include chemical admixtures as required or needed. Ground granulated blast furnace slag, fly ash or silica fume may be substituted for a portion of the Portland cement. Type IP, IS or IT blended cement may be used instead of Portland cement.

Mixes for all Portland cement concrete shall be designed by a Certified Concrete Mix Design Technician or an engineer licensed by the State of North Carolina.

When concrete for any one pour is furnished by multiple concrete plants, use the same mix design for all concrete, including sources and quantities of ingredients.

1000-2 MATERIALS

Refer to Division 10.

Item	Section
Air Entraining Agent	1024-3
Calcium Nitrite Corrosion Inhibitor	1024-3
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Type IT Blended Cement	1024-1
Water	1024-4

1000-3 PORTLAND CEMENT CONCRETE FOR PAVEMENT

(A) Composition and Design

Submit concrete paving mix design in terms of saturated surface dry weights on Materials and Tests Form 312U for approval at least 30 days before proposed use. Use a mix that contains at least 526 lb of cement per cubic yard, a maximum water cement ratio of 0.559, an air content in the range of 4.5% to 5.5%, a maximum slump of 1.5", a minimum flexural strength of 650 psi at 28 days and a minimum compressive strength of 4,500 psi at 28 days.

The cement content of the mix design may be reduced by no more than 20% and replaced with fly ash at a minimum rate of 1.2 lb of fly ash to each pound of cement replaced. Use a maximum water-cementitious material ratio not to exceed 0.538.

Section 1000

1 The cement content of the mix design may be reduced by no more than 50% and replaced
2 with blast furnace slag pound for pound.

3 Include in the mix design the source of aggregates, cement, fly ash, slag, water and
4 admixtures; the gradation and specific gravity of the aggregates; the fineness modulus of
5 the fine aggregate; and the dry rodded unit weight and size of the coarse aggregate.
6 Submit test results showing that the mix design conforms to the criteria, including the
7 1, 3, 7, 14 and 28-day strengths of the average of two 6" x 6" x 20" beams and the
8 average of two 6" x 12" cylinders for each age made and tested in accordance with
9 AASHTO R 39, T22 and T97. Design the mix to produce an average strength sufficient
10 to indicate that a minimum strength of 650 psi in flexure and 4,500 psi in compression
11 will be achieved in the field within 28 days.

12 If any change is made to the mix design, submit a new mix design.

13 If any major change is made to the mix design, also submit new test results showing the
14 mix design conforms to the criteria. Define a major change to the mix design as:

15 (1) A source change in coarse aggregate, fine aggregate, cement or pozzolan (applies
16 only to a change from one type of pozzolan to another; e.g., Class F fly ash to
17 Class C fly ash).

18 (2) A quantitative change in coarse aggregate (applies to an increase or decrease greater
19 than 5%), fine aggregate (applies to an increase or decrease greater than 5%), water
20 (applies to an increase only), cement (applies to a decrease only), or pozzolan
21 (applies to a decrease only).

22 Where concrete with a higher slump for hand methods of placing and finishing is
23 necessary, submit an adjusted mix design for approval to provide a maximum slump of 3"
24 and to maintain the water-cementitious material ratio established by the original mix
25 design.

26 **(B) Air Entrainment**

27 Entrain air in the concrete by the use of an approved air entraining agent dispensed with
28 the mixing water, unless prohibited.

29 Provide an air content of $5.0\% \pm 1.5\%$ in the freshly mixed concrete. The air content will
30 be determined in accordance with AASHTO T 121, T152 or T196. At the option of the
31 Engineer, the air content may be measured by the Chace indicator, AASHTO T 199, in
32 which case sufficient tests will be made to establish correlation with the test methods of
33 AASHTO T 121, T152 or T196. Concrete will not be rejected based on tests made in
34 accordance with AASHTO T 199.

35 **(C) Slump**

36 Provide concrete with a maximum slump of 1.5" where placed by a fully mechanized
37 paving train and no more than 3" where placed by hand methods.

38 The sample taken for determination of slump will be obtained immediately after the
39 concrete has been discharged onto the road.

40 **(D) Set Retarding Admixture and Water Reducing Admixture**

41 With permission, the Contractor may use an approved set retarding admixture,
42 an approved water reducing admixture or both to facilitate placing and finishing. Use
43 a quantity of set retarding admixture or water reducing admixture within the range shown
44 on the current list of approved admixtures maintained by the Materials and Tests Unit.

(E) Contractor's Responsibility for Process Control

Before or at the preconstruction conference, submit a plan detailing the process control and the type and frequency of testing and inspection necessary to produce concrete that meets the Specifications. During all batching and delivery operations assign a Certified Concrete Batch Technician on site whose sole duty is to supervise the production and control of the concrete. This duty includes the following:

- (1) Tests and inspections necessary to maintain the stockpiles of aggregates in an unsegregated and uncontaminated condition.
- (2) Calibration of admixture dispensing systems, weighing systems and water gauges.
- (3) Tests and adjustments of mix proportions for moisture content of aggregates.
- (4) Mixer performance tests before reducing mixing time of central mix plant to less than 90 seconds and at other times when deemed necessary by the Engineer.
- (5) Verifying the actual mixing time of the concrete after all materials are introduced into the mixer at the beginning of paving operations and at least once each month.
- (6) Testing all vibrators.
- (7) Tests necessary to document the slump and air content of the mix produced. Determine air content at least twice each day.
- (8) Tests for depth of the pavement in the plastic state.
- (9) Furnishing data to verify that the approved theoretical cement content has been met at intervals not to exceed 50,000 sy of pavement.
- (10) Signing all plant reports, batch tickets and delivery tickets.

The Department certifies technicians who satisfactorily complete examinations prepared and administered by the Division of Highways.

Perform all test procedures in compliance with the appropriate articles of Section 1000.

Tests may be witnessed by the Engineer. Document the results of all tests and inspections and make a copy available to the Engineer upon request. Take prompt action to correct conditions that have resulted in or could result in the submission of materials, products, or completed construction that do not conform to the *Standard Specifications*.

(F) Contractor Not Relieved of Responsibility for End Result

The Contractor will not be relieved of his obligation to produce a uniform pavement meeting Specifications by reason of:

- (1) The acceptance or approval by the Engineer of the concrete mix design or any adjustments;
- (2) Compliance with the concrete mix design and compliance with the testing requirements and other process control requirements by the Contractor; or
- (3) The failure of the Engineer to perform any tests in the process control, nor the performance of any tests in the process control that indicate compliance with the Specifications.

1000-4 PORTLAND CEMENT CONCRETE FOR STRUCTURES AND INCIDENTAL CONSTRUCTION**(A) Composition and Design**

Provide the class of concrete required by the contract.

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1 Submit proposed concrete mix designs for each class of concrete to be used in the work.
2 Mix proportions shall be determined by a testing laboratory approved by the Department.
3 Base mix designs on laboratory trial batches that meet Table 1000-1 and this section.

4 Submit mix designs in terms of saturated surface dry weights on Materials and Tests
5 Form 312U at least 35 days before proposed use. Adjust batch proportions to
6 compensate for surface moisture contained in the aggregates at the time of batching.
7 Changes in the saturated surface dry mix proportions will not be permitted unless revised
8 mix designs have been submitted to the Engineer and approved.

9 Accompany Materials and Tests Form 312U with a listing of laboratory test results of
10 aggregate gradation, air content, slump and compressive strength. List the compressive
11 strength of at least three 6" x 12" or 4" x 8" cylinders at the age of 7 and 28 days.

12 Perform laboratory tests in accordance with the following test procedures:

Property	Test Method
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump	AASHTO T 119
Compressive Strength	AASHTO T 22 and T23

13 The Engineer will review the mix design for compliance with the Specifications and
14 notify the Contractor as to its acceptability. Do not use a mix until written notice has
15 been received. Acceptance of the mix design does not relieve the Contractor of his
16 responsibility to furnish a product that meets the contract. Upon written request from the
17 Contractor, a mix design accepted and used satisfactorily on any Department project may
18 be accepted for use on other projects.

19 (B) Air Entrainment

20 Entrain air in the concrete unless otherwise indicated in the plans or in the Specifications.
21 Add an air entraining agent at the time of mixing to produce an air content in the freshly
22 mixed concrete of $6.0\% \pm 1.5\%$ when tested at the job site. Determine the air content in
23 accordance with AASHTO T 121, T152 or T196. Measurement of air content may also
24 be performed by the Chace indicator in accordance with AASHTO T 199, in which case
25 sufficient tests will be made in accordance with AASHTO T 121, T152 or T196 to
26 establish correlation with the Chace indicator. Concrete for structures will not be rejected
27 based on tests made in accordance with AASHTO T 199. Concrete for incidental
28 construction may be rejected based on an average of 3 or more tests made in accordance
29 with AASHTO T 199.

30 Air entraining agent may be added at the job site when permitted by the Engineer.

31 (C) Strength of Concrete

32 The compressive strength of the concrete will be considered the average compressive
33 strength test results of two 6" x 12" cylinders, or two 4" x 8" cylinders if the aggregate
34 size is not larger than size 57 or 57M. Make cylinders in accordance with AASHTO T 23
35 from the concrete delivered to the work. Make cylinders at such frequencies as the
36 Engineer may determine and cure them in accordance with AASHTO T 23 as modified
37 by the Department. Copies of these modified test procedures are available upon request
38 from the Materials and Tests Unit.

39 When the average compressive strength of the concrete test cylinders is less than the
40 minimum strength specified in Table 1000-1 and the Engineer determines if the concrete
41 strength will be acceptable. When the Engineer determines average cylinder strength is
42 below the specification, the in-place concrete will be tested. Based on these test results,
43 the concrete will either be accepted with no reduction in payment or accepted at
44 a reduced unit price or rejected as set forth in Article 105-3.

(D) Temperature Requirements

The concrete temperature at the time of placement shall be not less than 50°F nor more than 95°F except where other temperatures are required by Articles 420-4, 420-7, 420-14 and 420-15.

Do not place concrete without permission when the air temperature measured at the location of the concrete operation in the shade away from artificial heat is below 35°F.

When such permission is granted, uniformly heat the aggregates and/or water to a temperature not higher than 150°F. Heated concrete shall be between 55°F and 80°F at the time of placement.

**TABLE 1000-1
REQUIREMENTS FOR CONCRETE**

Class of Concrete	Min. Comp. Strength at 28 days	Maximum Water-Cement Ratio				Consistency Max. Slump		Cement Content			
		Air-Entrained Concrete		Non Air-Entrained Concrete		Vibrated	Non-Vibrated	Vibrated		Non-Vibrated	
		Rounded Aggregate	Angular Aggregate	Rounded Aggregate	Angular Aggregate			Min.	Max.	Min.	Max.
<i>Units</i>	<i>psi</i>					<i>inch</i>	<i>inch</i>	<i>lb/cy</i>	<i>lb/cy</i>	<i>lb/cy</i>	<i>lb/cy</i>
AA	4,500	0.381	0.426	-	-	3.5	-	639	715	-	-
AA Slip Form	4,500	0.381	0.426	-	-	1.5	-	639	715	-	-
Drilled Pier	4,500	-	-	0.450	0.450	-	5-7 dry 7-9 wet	-	-	640	800
A	3,000	0.488	0.532	0.550	0.594	3.5	4	564	677	602	602
B	2,500	0.488	0.567	0.559	0.630	2.5	4	508	610	545	654
B Slip Formed	2,500	0.488	0.567	-	-	1.5	-	508	610	-	-
Sand Lightweight	4,500	-	0.420	-	-	4	-	715	715	-	-
Latex Modified	3,000 7 day	0.400	0.400	-	-	6	-	658	658	-	-
Flowable Fill excavatable	150 max. at 56 days	as needed	as needed	as needed	as needed	-	Flow- able	-	-	40	100
Flowable Fill non-excavatable	125	as needed	as needed	as needed	as needed	-	Flow- able	-	-	100	as needed
Pavement	4,500 design, field 650 flexural, design only	0.559	0.559	-	-	1.5 slip form 3.0 hand place	-	526	-	-	-
Precast	See Table 1077-1	as needed	as needed	-	-	6	as needed	as needed	as needed	as needed	as needed
Prestress	per contract	See Table 1078-1	See Table 1078-1	-	-	8	-	564	as needed	-	-

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1 (E) Elapsed Time for Placing Concrete

2 Regulate the delivery so the maximum interval between the placing of batches at the
3 work site does not exceed 20 minutes. Place concrete before exceeding the times in
4 Table 1000-2. Measure the elapsed time as the time between adding the mixing water to
5 the mix and placing the concrete.

Air or Concrete Temperature Whichever is Higher	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below ^A	60 minutes	1 hr. 45 minutes
70°F through 79°F ^B	60 minutes	1 hr. 45 minutes
69°F or below ^B	1 hr. 30 minutes	2 hr. 15 minutes

6 **A.** Applicable to Class AA, A and Drilled Pier concrete.

7 **B.** Applicable to Class B concrete.

8 (F) Use of Set Retarding Admixtures

9 Use an approved set retarding admixture in all concrete placed in the superstructure of
10 bridges such that the concrete will remain workable until the entire operation of placing
11 and finishing, including corrective measures, if necessary, has been completed. The
12 Engineer may waive the use of set retarding admixture when conditions clearly indicate
13 that it is not needed.

14 Other structural concrete may contain an approved set retarding admixture when
15 permitted by the Engineer.

16 Use a quantity of set retarding admixture within the range shown on the current list of
17 approved admixtures issued by the Materials and Tests Unit.

18 (G) Use of Water Reducing Admixtures

19 By permission of the Engineer, the Contractor may use an approved water reducing
20 admixture to facilitate placing and finishing.

21 Use a quantity of water reducing admixture within the range shown on the current list of
22 approved admixtures issued by the Materials and Tests Unit.

23 (H) Use of Calcium Chloride

24 Calcium chloride may be used as a set accelerating agent where permitted by the
25 Engineer. Use one pound of calcium chloride per 100 lb of cement except where lesser
26 amounts are directed. Do not use calcium chloride where steel reinforcement, metal
27 conduit or other metals will be in contact with the concrete. Do not use calcium chloride
28 in concrete that has a temperature higher than 70°F, or when the air temperature is greater
29 than 70°F. Provide cold weather protection for concrete containing calcium chloride in
30 the same manner as is provided for concrete without calcium chloride.

31 Use calcium chloride in liquid form. Use a solution of one pound or less of calcium
32 chloride per one quart of water and mix well. To avoid incompatibility with other
33 additives, add the calcium chloride to the batch after all other ingredients have been put
34 into the mixer.

35 (I) Use of Fly Ash

36 Use Table 1000-3 to determine the maximum allowable water-cementitious material
37 (cement + fly ash) ratio for the classes of concrete listed. For all other classes, the

1 maximum water-cementitious material ratio will be the same as the water-cement ratio
2 listed in Table 1000-1.

TABLE 1000-3		
MAXIMUM WATER-CEMENTITIOUS MATERIAL RATIO		
Class of Concrete	Rounded Aggregate	Angular Aggregate
AA and AA Slip Form	.366	.410
A	.469	.512
B and B Slip Form	.469	.545
Pavement	.538	.538

3 **(J) Use of Ground Granulated Blast Furnace Slag**

4 For mixes that contain cement and ground granulated blast furnace slag, the
5 water-cementitious ratio (cement and slag) shall not exceed the water-cement ratio shown
6 in Table 1000-1.

7 **(K) Use of Calcium Nitrite Corrosion Inhibitor**

8 Units with calcium nitrite in a quantity less than specified are subject to rejection.
9 Furnish concrete cylinders to the Engineer, in a quantity to be specified, to verify the
10 concentrations of calcium nitrite in hardened concrete. Concrete that fails to contain
11 calcium nitrite at the required concentrations as tested is subject to rejection. Use
12 air-entraining, water-reducing and/or set-controlling admixtures compatible with calcium
13 nitrite solutions. Strictly adhere to the manufacturer's written recommendations
14 regarding the use of admixtures, including storage, transportation and method of mixing.
15 If preferred, use calcium nitrite, which acts as an accelerator, in conjunction with
16 a retarder to control the set of concrete, as per the manufacturer's recommendation. Add
17 an approved calcium nitrite corrosion inhibitor (30% solids) to the concrete mix at the
18 batch plant for the bridge elements identified by the plan notes. Use the inhibitor at
19 a minimum rate of 3.0 gal/cy. Ensure that the hardened concrete contains at least
20 5.1 lb/cy nitrite (NO₂) when tested in accordance with Materials and Tests Method
21 Chem. C-20.0. The preceding paragraph does not apply to concrete used in prestressed
22 concrete members. Concrete used in prestressed concrete members shall be tested in
23 accordance with Subarticle 1078-4(G).

24 **1000-5 HIGH EARLY STRENGTH PORTLAND CEMENT CONCRETE**

25 Use high early strength Portland cement concrete when required by contract. When not
26 required, it may be used at the Contractor's option with approval of the Engineer.

27 For all classes of concrete, high early strength concrete may be produced by using
28 Type III Portland cement. To produce high early strength concrete with regular cement, use
29 a higher class of concrete as follows:

30 For Class A and Class B, use Class AA with a cement content of at least 677 lb/cy. For
31 Class B slip form, use Class AA slip form with a cement content of at least 677 lb/cy. Other
32 classes that lend themselves to high early strength with regular cement will be reviewed by
33 the Engineer on a case-by-case basis.

34 **1000-6 FLOWABLE FILL**

35 Flowable fill consists of Portland cement, water, pozzolan and/or fine aggregate and,
36 optionally, concrete admixtures.

37 Submit the proposed mix design on Materials and Tests Form 312U at least 35 days before
38 use. Use a testing laboratory approved by the Department to determine mix proportions based
39 on laboratory trial batches meeting Table 1000-1.

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1 State on Form 312U the intended use of the material. Accompany Form 312U with a listing
2 of compressive strength of at least three 4" x 8" cylinders at the age of 28 or 56 days,
3 depending on whether the mix is to be excavated or not. Air cure the cylinders during the
4 entire period before testing. The Engineer will advise the Contractor in writing of the
5 acceptability of the mix design.

6 **1000-7 LATEX MODIFIED CONCRETE**

7 **(A) Materials**

8 Refer to Division 10.

Item	Section
Coarse Aggregate, standard size No. 78M	1014-2
Fine Aggregate	1014-1
Portland Cement	1024-1
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Type IT Blended Cement	1024-1
Water	1024-4

9 Do not use Type III high early strength cement.

10 Use a formulated latex admixture that is a non-hazardous, film forming and polymeric
11 emulsion in water and is homogeneous and uniform in composition. Add all stabilizers at
12 the point of manufacture.

13 Use a latex modifier conforming to Table 1000-4.

Property	Requirement
Polymer Type	Styrene Butadiene: 68 ± 4% Styrene 32 ± 4% Butadiene
Average Polymer Particle Size	1500 to 2500 Angstroms
Emulsion Stabilizers	Anionic and non-ionic surfactants
Percent Solids	46.5% to 49.0%
Weight per gallon at 75°F	8.40 to 8.60 lb
pH	9.5 to 11.0
Shelf Life	2 Years
Color	White

14 Provide a Type 5 material certification for each load of latex emulsion admixture in
15 accordance with Article 106-3. Test admixture samples to verify compliance with the
16 requirements before use. Allow 7 days for sampling and testing after delivery to the
17 project.

18 Do not allow the temperature of latex emulsion admixture to fall below 35°F at any time
19 or exceed 85°F after delivery to the project.

20 For latex emulsion that has been in storage, use a transfer pump and lines to recirculate it
21 before using.

22 For latex modified concrete, use a workable mixture that meets Table 1000-5.

23 Measure the slump 4 to 5 minutes after discharge from the mixer.

24 Submit the latex modified concrete mix design, completed by the latex emulsion
25 manufacturer, to the Engineer for review.

TABLE 1000-5 PROPERTIES OF LATEX MODIFIED CONCRETE	
Property	Requirement
Cement Content, lb/cy	658 min.
Latex Emulsion Admixture, gal/cy	24.5 min.
Air Content of Plastic Mix, %	3.5 - 6.5
Slump, inches	3 - 6
% Fine Aggregate as percent of total aggregate by weight	50 - 55
7 day Compressive Strength, psi	3,000 min.
Water-Cement Ratio by weight	0.40 max.

1 **(B) Equipment**

2 Before beginning any work, obtain approval for all equipment to be used for deck
3 preparation, mixing, placing, finishing and curing the latex modified concrete.

4 Use sandblasting equipment capable of removing all clay, salt deposits, oil and grease
5 deposits and all other foreign matter. Provide traps or separators to remove oil and water
6 from the compressed air. Use traps or separators of adequate size and drain them
7 periodically during operations. For proportioning and mixing, use self-contained, mobile
8 and continuously mixing equipment that meets the following requirements:

9 Use a self-propelled mixer that is capable of carrying sufficient unmixed dry, bulk
10 cement, sand, coarse aggregate, latex modifier and water to produce at least 6 cy of
11 concrete on site.

12 Use a mixer that is capable of positive measurement of cement introduced into the mix.
13 Use a recording meter that is visible at all times and equipped with a ticket printout to
14 indicate the quantity of cement.

15 Calibrate the mixers to accurately proportion the specified mix. Before placing latex
16 modified concrete, perform calibration and yield tests under the Engineer's supervision in
17 accordance with the Department's written instructions. Copies of these written
18 instructions are available from the Materials and Tests Unit. Perform the calibration and
19 yield tests using the material to be used on the project. Recalibrate the mixer after any
20 major maintenance operation on the mixer, anytime the source of materials changes or as
21 directed. Furnish all materials and equipment necessary to perform the calibrations and
22 yield tests.

23 Use a mixer that controls the flow of water and latex emulsion into the mix. Measure the
24 flow rate of water and the latex emulsion with a calibrated flowmeter coordinated with
25 both the cement and aggregate feeding mechanisms and the mixer. Adjust the flow rate,
26 as necessary, to control the slump and ensure that the water-cement ratios are met. In
27 addition to flowmeters, use mixers with accumulative water and latex meters capable of
28 indicating the number of gallons, to the nearest 0.1 gallon, introduced into the mixer.
29 Filter water and latex with a suitable mesh filter before it flows through the accumulative
30 water and latex meters.

31 Calibrate the mixer to automatically proportion and blend all components of the indicated
32 composition on a continuous or intermittent basis as the finishing operation requires.
33 Provide a mixer that discharges mixed material through a conventional chute and is
34 capable of spraying water over the placement width as it moves ahead to ensure that the
35 surface to be overlaid is wet before receiving the modified material.

36 Mount a tachometer on the unit to indicate the drive shaft speed.

37 Use adequate hand tools for placing and leveling concrete down to approximately the
38 correct level for striking off with the screed.

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1 Use a finishing machine that meets the approval of the Engineer and the requirements of
2 the contract. Use a self-propelled finishing machine capable of forward and reverse
3 movement under positive control. Use a machine with at least 2 finishing devices, one
4 that is a vibrating screed and the other either a vibrating screed, oscillating screed, or one
5 or more rotating cylindrical drums 48" long or less and operating between 1,500 and
6 2,500 vpm. Make certain the finishing machine can finish the surface to within one foot
7 of the edges of the area being placed. Raise all screeds when the finishing machine is
8 moving backwards over the screeded surface.

9 Use screeds with a vibration frequency that is variable between 3,000 and 6,000 vpm
10 with positive controls. Use screeds with a metal covered bottom face not less than
11 4" wide. Provide screeds with positive control of the vertical position.

12 Use supporting rails for travelling of the finishing machine rigid enough to eliminate
13 deflection from the weight of the machine.

14 (C) Proportioning and Mixing of Modified Compositions

15 Meet the following requirements when proportioning and mixing modified materials:

16 Use mobile continuous mixers that accurately proportion all materials for the specified
17 mixture. Operate the proportioning equipment at the manufacturer's recommended speed
18 verified with the tachometer during calibration and normal operations.

19 Yield checks and other checks are permitted.

20 1000-8 MEASURING MATERIALS

21 (A) Weighing Cement

22 Measure cement by weight on scales separate from those used for other materials and in
23 a hopper that is entirely free and independent of the hoppers used for weighing the
24 aggregates. When the quantity of cement in a batch exceeds 30% of the full capacity of
25 the scale, ensure the quantity of cement as indicated by the scale is within $\pm 1\%$ of the
26 required weight. For smaller batches, ensure the quantity of cement as indicated by the
27 scale be not less than the required amount or more than 4% in excess. Equip all beam
28 type scales with a tare beam.

29 (B) Weighing Aggregates

30 Measure aggregates by weight. Base batch weights on saturated surface dry materials
31 and which are the required weights plus the total weight of surface moisture contained in
32 the aggregates. Ensure the individual aggregates, as weighed, are within $\pm 2\%$ of the
33 required weights.

34 (C) Water

35 Measure water by volume or by weight. Ensure the quantity of water measured is
36 within $\pm 1\%$ of the required amount.

37 (D) Admixture Dispensing Systems

38 Provide a separate dispensing system with separate fill and discharge lines for each type
39 of admixture to be used, except that admixtures may be measured and introduced into the
40 mix manually if approval has been obtained. Ensure each system is capable of
41 measuring, displaying and discharging the required amount of admixture into the mix.
42 Keep dispensing systems clean and in good operating condition. Use a dispensing system
43 that is either:

44 (1) Manually operated, self contained; or

45 (2) Semi-automatic or automatic, self-contained; or

46 (3) Interfaced to operate automatically with the concrete batching control panel.

1 Have the admixture dispenser dispense the required quantity of admixture for each
 2 concrete batch within an accuracy of $\pm 3\%$. Check the accuracy of the dispenser as
 3 provided below. Check the accuracy at the point of discharge, or through a bypass valve
 4 suitable for obtaining a calibrated sample of admixture and at the volumes normally used
 5 for one half mixer capacity and for full mixer capacity. Determine the accuracy at the
 6 time of installation and check daily during the early part of each day's operation.

7 Include in each system a graduated measuring unit into which the admixture is batched to
 8 permit a quick visual check of accuracy before its discharge. Ensure the measuring unit
 9 is clearly graduated and be of sufficient size to hold the maximum anticipated dose for
 10 one batch. Clearly mark the measuring unit for the type of admixture to be used.

11 Control the discharge sequence so an admixture will not be brought into contact with raw
 12 cement or another admixture before being diluted through contact with the mixing water
 13 in the mixer. Where 2 types of admixtures are being used, do not discharge them into the
 14 mix simultaneously. Add the air entraining agent with the first addition of water and add
 15 any other chemical admixture with the final addition of water, unless otherwise
 16 permitted.

17 Construct the discharge lines to completely empty after each cycle. Locate the admixture
 18 dispensing systems so the batching plant operator will have a visual verification of the
 19 actual quantity of admixture batched.

20 Use air entraining admixtures in accordance with the manufacturer's recommendations
 21 and in such quantity to provide the specified air content in freshly mixed concrete. Use
 22 a quantity of set retarding admixture and of water reducing admixture per 100 lb of
 23 cement that is within the range recommended on the current list of approved admixtures
 24 issued by the Materials and Tests Unit.

25 **1000-9 BATCHING PLANT**

26 **(A) General**

27 Plants located on the Department rights of way shall conform to Article 107-3.

28 Have ready mixed concrete plants inspected and approved by the Department before they
 29 are used to produce concrete, either paving, structural or incidental, for the project.
 30 Plants shall meet all the applicable requirements of these *Standard Specifications*, and in
 31 addition, ensure each ready mix plant provides at least 3 acceptable truck mixers or truck
 32 agitators available for use. Use trucks that have an identifying number. Plants approved
 33 by the Department will be placed on a list of approved plants available to the Contractor.
 34 All plants will be subject to reinspection at intervals selected by the Engineer.
 35 Reapproval after each inspection will be contingent on continuing compliance with the
 36 *Standard Specifications*.

37 **(B) Bins and Hoppers**

38 Provide bins with separate compartments for fine aggregates and for each required size of
 39 coarse aggregate in the batching plant. Design each compartment to discharge efficiently
 40 and freely into the weighing hopper. Provide control so, as the quantity desired is being
 41 approached, the material may be added slowly and shut off with precision. Construct
 42 weighing hoppers to eliminate accumulation of tare materials and to discharge fully
 43 unless otherwise permitted. Provide a port or other opening for removing an overload of
 44 any one of the several materials from the hopper.

45 **(C) Scales**

46 Use either the beam type, load cell type or the springless dial type scales for weighing
 47 aggregates and cement. Ensure the minimum graduation on beam or dial is not more than
 48 0.1% of the total capacity of the scale. Methods of weighing, other than beam or
 49 springless dial scales, may be approved by the Engineer provided they meet the required

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1 weighing tolerances. Ensure the scales are accurate within 0.5% under operating
2 conditions. Make available ten 50 lb test weights at the plant for checking accuracy. Use
3 test weights which meet the U.S. Bureau of Standards requirements for calibrating and
4 testing equipment. Keep all exposed fulcrums, clevises and similar working parts of
5 scales clean. When beam type scales are used, make provisions for indicating to the
6 operator that the required load in the weighing hopper is being approached. Ensure the
7 device indicates at least the last 50 lb of load and design it to give a positive indication of
8 overload of the scales. During charging of the hopper, have all indicating devices in full
9 view of the operator and provide convenient access to all controls. Ensure the indicating
10 devices are in the immediate vicinity of the operator and easily readable by the operator.

11 (D) Water Measuring Devices

12 Use devices for measurement of the water which are readily adjustable and are capable of
13 being set to deliver the required amount and cut off the flow automatically when this
14 amount has been discharged. Under all operating conditions the device shall have
15 accuracy within 1% of the quantity of water required for the batch. Arrange the device so
16 variable pressures in the water supply line will not affect the measurements. Use
17 measuring tanks of adequate capacity to furnish the maximum mixing water required and
18 equip them with outside taps and valves to provide for checking their calibration unless
19 other means are provided for readily and accurately determining the amounts in the tank.

20 1000-10 MIXERS AND AGITATORS

21 (A) General

22 Mixers are defined as equipment to mix concrete and may be stationary or truck
23 mounted. Agitators are defined as equipment used to haul central mixed concrete and
24 may be truck mixers or truck agitators. Provide a metal plate or plates attached to each
25 mixer and agitator in a prominent place on which the manufacturer has plainly marked
26 the mixing speed of the drum or paddles and the maximum capacity of the drum or
27 container in terms of volume of mixed concrete. On truck mixers and agitators, show the
28 manufacturer's recommended agitating and mixing speed of rotation of the mixing drum
29 or blades. Equip stationary mixers with an acceptable timing device that will not permit
30 the batch to be discharged until the specified mixing time has elapsed. Equip truck
31 mixers with counters to verify the number of revolutions of the drum or blades. Actuate
32 the counters at the initial time the drums have reached mixing speed.

33 Examine mixers and agitators periodically for changes in condition due to accumulation
34 of hard concrete or mortar, wear of blades or any other condition which decreases mixing
35 efficiency. Mixers are unacceptable when the radial height or other dimension of the
36 blade has worn below 90% of the original dimension. This radial height excludes any
37 lips on the blade and is the height of the blade running perpendicular to the shell of the
38 drum. Where such conditions are found, do not use the units until they are corrected.

39 Also examine mixers and agitators periodically for general mechanical condition,
40 including water measuring and discharge apparatus, identifying number on trucks,
41 condition of the blades, speed of rotation of the drum and condition of the drum.

42 (B) Mixer Capacity

43 Do not load truck mixers with concrete with more than 63% of the gross volume of the
44 drum. Use mixers capable of combining the ingredients of the concrete into a thoroughly
45 mixed and uniform mass and of discharging the concrete with a satisfactory degree of
46 uniformity. Use stationary mixers, when loaded at the manufacturer's guaranteed mixing
47 capacity and the concrete mixed for the prescribed mixing time, capable of combining the
48 ingredients of the concrete into a thoroughly mixed and uniform mass and discharging
49 the concrete with satisfactory uniformity.

1 Use at least 20% of the rated mixing capacity as the minimum quantity of concrete
2 permitted to be mixed or agitated in any mixer.

3 **(C) Agitator Capacity**

4 Load the agitator to not exceed 80% of the gross drum volume and have it be capable of
5 maintaining the concrete in a thoroughly mixed and uniform mass and of discharging the
6 concrete with a satisfactory degree of uniformity.

7 **(D) Consistency Tests**

8 The Engineer may, from time to time, make slump tests to measure consistency of the
9 concrete. Take individual samples at approximately the 1/5th point, the midpoint and the
10 4/5th point of the load, using AASHTO T 119. Such tests will be made within
11 20 minutes of discharge of that portion of the load. If the results vary by more than 1" in
12 slump, do not use the mixer or agitator unless the condition is corrected.

13 **1000-11 MIXING AND DELIVERY**

14 **(A) General**

15 Mix and deliver concrete to the site of the work by one of the following methods, except
16 where other methods are approved. Maintain responsibility for controlling the materials
17 and operations as to produce uniform concrete meeting Specifications requirements.

18 When concrete is being produced for structures and incidental construction in accordance
19 with Article 1000-4, have present during all batching operations a Certified Concrete
20 Batch Technician employed by the Contractor or concrete supplier. During batching and
21 delivery, the sole duty of this employee is to supervise the production and control of the
22 concrete. Perform moisture tests, adjust mix proportions of aggregates for free moisture,
23 complete and sign Batch Tickets (Materials and Tests Form 903) or approved delivery
24 tickets and assure quality control of the batching. Delivery tickets will be permitted
25 instead of batch tickets (Materials and Tests Form 903) provided they have been
26 reviewed and approved by the Materials and Tests Unit. The Department certifies
27 technicians who satisfactorily complete examinations prepared and administered by the
28 Department.

29 **(1) Central Mixed Concrete**

30 Concrete that is mixed completely in a stationary mixer and the mixed concrete
31 transported to the point of delivery in a truck agitator or in a truck mixer operating at
32 agitating speed or in non agitating equipment approved by the Engineer. Perform
33 mixing within the capacity and at the mixing speeds recommended by the
34 manufacturer.

35 **(2) Transit Mixed Concrete**

36 Concrete that is mixed completely in a truck mixer while at the batching plant, in
37 transit, or at the work site.

38 **(3) Shrink Mixed Concrete**

39 Concrete that is mixed partially in a stationary mixer at a central mixing plant and
40 completed as transit mixed concrete. Place all ingredients for a batch in the
41 stationary mixer, partially mix before any concrete is discharged to the truck mixer
42 and do not exceed the rated capacity of the equipment for the batch size. The mixing
43 time at the stationary mixer may be reduced to the minimum necessary to
44 intermingle the ingredients, and the mixing may be completed in the truck mixer.
45 Use the number of mixing revolutions in the truck mixer as specified for transit
46 mixed concrete or reduce as indicated by mixer performance tests.

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1 (B) Mixing Time for Central Mixed Concrete

2 Mixing time begins when all solid materials are in the mixing compartment and ends
3 when any part of the concrete begins to discharge. In charging the mixer, water will enter
4 in advance of cement and aggregate. Ensure all the water is substantially in the drum
5 before 1/3 of the specified mixing time has elapsed. Count transfer time in multiple drum
6 mixers as part of the mixing time.

7 Where mixer performance tests are not made, use a minimum mixing time of 90 seconds,
8 providing that blending of materials during charging is achieved to the satisfaction of the
9 Engineer. The minimum mixing time for an individual mixer is that which, as shown by
10 mixer performance tests, will produce concrete in accordance with Table 1000-6, except
11 that the mixing time shall not be less than 50 seconds under any circumstances.
12 Maximum mixing time excluding discharge time is 150 seconds.

13 Sampling and testing for mixer performance tests will be done as provided below.
14 Charge the mixer to its rated capacity with the materials and proportions to be used in the
15 work and mixed at the recommended mixing speed to the target time. Stop mixing and
16 begin discharging. Two samples of sufficient size to make the required tests will be
17 taken after discharge of approximately 15% and 85% of the load.

**TABLE 1000-6
REQUIREMENTS FOR UNIFORMITY OF CONCRETE**

Property	Requirement	Test Method
Difference in Test Samples Air Content, percent by volume of concrete	1.0%	AASHTO T 152
Slump	1.0"	AASHTO T 119
Coarse aggregate content, portion by weight of each sample retained on the No. 4 sieve	6.0%	AASHTO M 157
Weight	1.0 lb	AASHTO T 121
Average Compressive Strength at 7 days, percent of average	10.0% ^A	AASHTO T 22 AASHTO T 23

18 **A.** Tentative approval may be granted pending 7 day compressive strength tests.

19 Each of the 2 samples of concrete will be separately tested for the properties listed in
20 Table 1000-6. Tests will be conducted in accordance with the test procedures specified
21 in Table 1000-6 or procedures established by the Materials and Tests Unit.

22 The mixer performance test described above will be performed on at least 2 batches of
23 concrete. For the performance test to be acceptable, have all tests in each batch tested
24 meet the requirements listed above.

25 The Engineer may recheck mixer performance at any time when, in his opinion,
26 satisfactory mixing is not being accomplished.

27 Where satisfactory mixing cannot be accomplished in 90 seconds, the Engineer may
28 increase the mixing time or require that the mixer be repaired or replaced before any
29 further mixing can be done.

30 (C) Truck Mixers and Truck Agitators

31 When a truck mixer is used for complete mixing, mix each batch of concrete for at least
32 70 revolutions of the drum or blades at the rate of rotation designated by the
33 manufacturer of the equipment as mixing speed, unless otherwise directed by the
34 Engineer. Unless the mixer is equipped with a counter which will distinguish between
35 mixing and agitating speeds, perform the minimum required number of revolutions of the
36 drum at mixing speed as directed, either at the batching plant before the mixer leaves
37 for the work site and/or at the work site before the concrete is discharged.

1 Perform any additional mixing at the speed designated by the manufacturer of the
2 equipment as agitating speed. Put all materials including mixing water in the drum
3 before actuating the revolution counter for determining the number of revolutions of the
4 drum.

5 When a truck mixer or truck agitator is used to transport concrete that has been
6 completely mixed in a stationary mixer, perform mixing during transport at agitating
7 speed.

8 Provide concrete, when discharged from truck mixers or truck agitators, of the
9 consistency and workability required for the work. Control the rate of discharge of the
10 plastic concrete from the mixer drum by the speed or rotation of the drum in the
11 discharge direction with the discharge gate fully open. If additional mixing water is
12 necessary to produce the slump necessary for proper placement, add it only with
13 permission and rotate the truck mixer drum at least 25 revolutions at mixing speed before
14 discharge of any concrete. Additional mixing water will be allowed only if the maximum
15 specified water content per cubic yard is not exceeded.

16 **(D) Delivery**

17 Use a ticket system for recording the transportation of batches from the proportioning
18 plant to the site of the work. Use tickets furnished by the Engineer and fill it out in
19 accordance with instructions issued by the Engineer. Issue the tickets to the truck
20 operator at the proportioning plant for each load and have them signed by the plant
21 inspector, which will signify that the concrete in the truck has been inspected before
22 departure. Ensure each ticket shows the time batching was completed and if transit
23 mixed, the number of revolutions at mixing speed, if any, at the plant. Deliver the tickets
24 to the inspector at the site of the work. Do not use loads which do not carry such tickets
25 and loads which do not arrive in satisfactory condition within the time limits specified in
26 the work.

27 **1000-12 VOLUMETRIC MIXED CONCRETE**

28 Upon written request by the contractor, the Department may approve the use of concrete
29 proportioned by volume. The volumetric producer must submit and have approved a process
30 control plan and product quality control plan by the Materials and Tests Unit. If concrete is
31 proportioned by volume, the other requirements of these specifications with the following
32 modifications will apply. Unless otherwise approved by the Department, use of concrete
33 proportioned by volume shall be limited to Class B concrete and no more than 30 cy per unit
34 per day.

35 **(A) Materials**

36 Use materials that meet the requirements for the respective items except that they will be
37 measured by a calibrated volume-weight relationship.

38 Storage facilities for all material shall be designed to permit the Department to make
39 necessary inspections before the batching operations. The facilities shall permit
40 identification of approved material at all times and shall be designed to avoid mixing
41 with, or contaminating by, unapproved material. Coarse and fine aggregate shall be
42 furnished and handled so variations in the moisture content affecting the uniform
43 consistency of the concrete is avoided.

44 Moisture content of the coarse and fine aggregate will be made available onsite for the
45 Engineer's review for each load. The frequency of moisture testing will be dependent on
46 certain variables such as weather, season and source; however, moisture tests should be
47 performed at least once at the beginning of the work day for each source material.
48 Additional daily moisture tests for the coarse and fine aggregate shall be performed if
49 requested by the Engineer.

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1 Unused materials should be emptied from hopper daily. Concrete should not be mixed
2 with materials left in the hopper overnight.

3 (B) Equipment

4 Provide volumetric mixers with rating plates indicating that the performance of the mixer
5 is in accordance with the Volumetric Mixer Manufacturer Bureau or equivalent. Mixers
6 must comply with ASTM C685. Unless otherwise specified, all mixing operations must
7 be in strict accordance with the manufacturer's recommended procedures. Such
8 procedures shall be provided to the Department for review upon request.

9 The volumetric mixer shall be capable of carrying sufficient unmixed dry bulk cement,
10 pozzolan (if required), fine aggregate, coarse aggregate, admixtures and water, in
11 separate compartments and accurately proportioning the specified mix. Each batching or
12 mixing unit (or both) shall carry in a prominent place a metal plate or plates on which are
13 plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed
14 and the weight-calibrated constant of the machine in terms of a revolution counter or
15 other output indicator.

16 The concrete mixing device shall be an auger-type continuous mixer used in conjunction
17 with volumetric proportioning. The mixer shall produce concrete, uniform in color and
18 appearance, with homogeneous distribution of the material throughout the mixture.
19 Mixing time necessary to produce uniform concrete shall be established by the contractor
20 and shall comply with other requirements of these specifications. Only equipment found
21 acceptable in every respect and capable of producing uniform results will be permitted.

22 Each volumetric mixer shall be equipped with an onboard ticketing system that will
23 electronically produce a record of all material used and their respective weights and the
24 total volume of concrete placed. Alternate methods of recordation may be used if
25 approved by the Engineer. Tickets shall identify at least the following information:

- 26 (1) Contractor Name
- 27 (2) Contractor Phone Number
- 28 (3) NCDOT Project No. and TIP No.
- 29 (4) Date
- 30 (5) Truck No.
- 31 (6) Ticket No.
- 32 (7) Time Start/End of Pour
- 33 (8) Mix ID and Description (Strength)
- 34 (9) Aggregate Moisture Before Mixing

35 (C) Proportioning Devices

36 Volume proportioning devices, such as counters, calibrated gate openings or flow meters,
37 shall be easily accessible for controlling and determining the quantities of the ingredients
38 discharged. All indicating devices that affect the accuracy of proportioning and mixing
39 of concrete shall be in full view of and near enough to be read by the operator and
40 Engineer while concrete is being produced. In operation, the entire measuring and
41 dispensing mechanism shall produce the specified proportions of each ingredient.

42 Provide positive control of the flow of water and admixtures into the mixing chamber
43 with a volumetric mixer. Indicate water flow by a flow meter and be readily adjustable to
44 provide for slump control and/or minor variations in aggregate moisture. Provide a mixer
45 capable of continuously circulating or mechanically agitating the admixtures.

46 Dispense liquid admixtures through a controlled, calibrated flow meter. A positive
47 means to observe the continuous flow of material shall be provided. If an admixture
48 requires diluting, the admixture shall be diluted and thoroughly mixed before introducing
49 the admixture into the dispenser. When admixtures are diluted, the ratio of dilution and
50 the mixing shall be approved by and performed in the presence of the Department.

The volumetric mixer shall be capable of measurement of cement, pozzolan (if required), liquids and aggregate being introduced into the mix.

(D) Calibration

Volume-weight relationships will be based on calibration. The proportioning devices shall be calibrated by the contractor before the start of each NCDOT job and subsequently at intervals recommended by the equipment manufacturer. Calibrations will be performed in the presence of the Department and subject to approval from the Department. Calibration of the cement and aggregate proportioning devices shall be accomplished by weighing (determining the mass of) each component. Calibration of the admixture and water proportioning devices shall be accomplished by weight (mass) or volume. Tolerances in proportioning the individual components will be as follows:

TABLE 1000-7 VOLUMETRIC MIXED CONCRETE CALIBRATION TOLERANCES	
Item	Tolerance
Cement, Weight (Mass) percent	0 to +4
Fine Aggregate, Weight (Mass) percent	± 2
Coarse Aggregate, Weight (Mass) percent	± 2
Admixtures, Weight (Mass) or Volume percent	± 3
Water, Weight (Mass) or Volume percent	± 1

Each volumetric mixer must be accompanied at all times by completed calibration worksheets and they shall be made available to the Department upon request.

(E) Verification of Yield

Verification of the proportioning devices may be required at any time by the Department. Verification shall be accomplished by proportioning the rock and sand based on the cement meter count for each concrete mobile mixer. Once the count (revolutions) for 94 lb of cement has been determined then delivery of the correct amount of rock and sand can be verified.

(F) Uniformity

When concrete is produced, have present during all batching operations a Certified Concrete Batch Technician. During batching and placement, the sole duty of this employee is to supervise the production and control of the concrete, perform moisture tests, adjust mix proportions of aggregates for free moisture, complete and sign approved delivery tickets and assure quality control of the batching.

Two samples of sufficient size to make the required tests will be taken after discharge of approximately 15% and 85% of the load. Each of the 2 samples of concrete will be separately tested for the properties listed in Table 1000-7. Tests will be conducted in accordance with the test procedures specified in Table 1000-7 or procedures established by the Materials and Tests Unit. The Engineer may recheck mixer performance at any time when, in his opinion, satisfactory mixing is not being accomplished.

SECTION 1002 SHOTCRETE PRODUCTION AND DELIVERY

1002-1 DESCRIPTION

This section addresses shotcrete to be used for temporary support of excavations and other applications in accordance with the contract. Produce shotcrete by either the dry-mix or wet-mix process composed of Portland cement, fine and/or coarse aggregates, water and at the Contractor's option, pozzolans. Include chemical admixtures as required or needed for shotcrete produced by the wet-mix process. Ground granulated blast furnace slag, fly ash or

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1 silica fume may be substituted for a portion of the Portland cement. Type IS, IP or IT blended
2 cement may be used instead of Portland cement.

3 Mixes for all shotcrete shall be designed by a Certified Concrete Mix Design Technician or an
4 engineer licensed by the State of North Carolina. Shotcrete shall be applied by a nozzelman
5 certified as an ACI Shotcrete Nozzelman in accordance with *ACI Certification*
6 *Publication CP-60*. Nozzlemen shall be certified in either dry-mix or wet-mix shotcrete
7 based on the process to be used for the work.

8 **1002-2 MATERIALS**

9 Refer to Division 10.

Item	Section
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Type IT Blended Cement	1024-1
Water	1024-4

10 **1002-3 SHOTCRETE FOR TEMPORARY SUPPORT OF EXCAVATIONS**

11 **(A) Composition and Design**

12 Submit proposed shotcrete mix designs for each shotcrete mix to be used in the work.
13 Mix proportions shall be determined by a testing laboratory approved by the Department.
14 Submit shotcrete mix designs in terms of saturated surface dry weights on Materials and
15 Tests Form 312U at least 35 days before proposed use. Adjust batch proportions to
16 compensate for surface moisture contained in the aggregates at the time of batching.
17 Changes in the saturated surface dry mix proportions will not be permitted unless revised
18 shotcrete mix designs have been submitted to the Engineer and approved.

19 The Engineer will review the shotcrete mix design for compliance with the contract and
20 notify the Contractor as to its acceptability contingent upon compressive strength test
21 results for cores from preconstruction test panels. Do not use a shotcrete mix until
22 written notice has been received. Acceptance of the shotcrete mix design does not relieve
23 the Contractor of his responsibility to furnish a product that meets this contract. Upon
24 written request from the Contractor, a shotcrete mix design accepted and used
25 satisfactorily on any Department project may be accepted for use on other projects.

26 **(B) Chemical Admixtures**

27 Use a quantity of chemical admixture within the range shown on the current list of
28 approved admixtures issued by the Materials and Tests Unit.

29 **(C) Strength of Shotcrete**

30 Provide shotcrete with a compressive strength at 3 and 28 days of at least 2,000 psi and
31 4,000 psi, respectively. The compressive strength of the shotcrete will be considered the
32 average compressive strength test results of 3 cores from the same test panel at each age.

33 **(D) Preconstruction Test Panels**

34 Before beginning construction, provide one preconstruction test panel for each shotcrete
35 mix design and nozzlemen using the same equipment that will be used for the work. Use
36 3 ft x 3 ft forms at least 3.5" thick for preconstruction test panels.

1 Batch, deliver, mix and apply shotcrete in accordance with Subarticles 1002-3(E)
2 and 1002-3(F) and the contract. Make preconstruction test panels in the presence of the
3 Engineer with forms in a vertical position and from the same shooting position
4 anticipated for construction. Do not disturb test panels for the first 24 hours after
5 shotcreting.

6 **(E) Mixing and Delivery**

7 Produce shotcrete of required strength, consistency, quality and uniformity with
8 minimum rebound. Do not use rebound or previously expanded material in the shotcrete
9 mix. Thoroughly mix materials in sufficient quantity to place shotcrete continuously.
10 Regulate the delivery so the maximum interval between the shooting of batches at the
11 work site does not exceed 20 minutes. Comply with Articles 1000-9 through 1000-12 to
12 the extent applicable for shotcrete instead of concrete.

13 **(F) Shooting Requirements**

14 Use equipment capable of handling and shooting shotcrete at a steady uninterrupted flow.
15 Use air supply systems that supply clean, dry air free of contamination and capable of
16 maintaining sufficient nozzle velocity at all times. Apply shotcrete with the same
17 equipment and methods as used for the preconstruction test panels.

18 The shotcrete temperature at the time of shooting shall be not less than 50°F nor more
19 than 90°F. Do not apply shotcrete during heavy rains or runoff or high winds so the
20 nozzle stream separates during shooting. Do not apply shotcrete if surface to receive
21 shotcrete is frozen or the air temperature measured at the location of the shotcreting
22 operation in the shade away from artificial heat is below 40°F. Apply shotcrete before
23 the time between adding the mixing water to the shotcrete mix and shooting the shotcrete
24 exceeds 60 minutes.

25 **(G) Production Test Panels**

26 Provide one production test panel for every 33 cy of shotcrete with at least one test panel
27 for each day shotcreting occurs. Use 18" x 18" forms at least 3.5" thick for production
28 test panels. Make production test panels with forms in a vertical position from the same
29 shooting position and at the same time as shotcreting is done. Do not disturb test panels
30 for the first 24 hours after shotcreting.

31 **SECTION 1003**

32 **GROUT PRODUCTION AND DELIVERY**

33 **1003-1 DESCRIPTION**

34 This section addresses grout to be used for traffic barriers, foundations, retaining walls, slopes
35 and other applications in accordance with the contract. Produce non-metallic grout composed
36 of Portland cement and water and at the Contractor's option, fine aggregate and pozzolans.
37 Include chemical admixtures as required or needed. Ground granulated blast furnace slag, fly
38 ash or silica fume may be substituted for a portion of the Portland cement. Provide nonshrink,
39 freeze-thaw durable, sand cement or neat cement grout as required. Define "sand cement
40 grout" as grout with fine aggregate and "neat cement grout" as grout without fine aggregate.

41 Mixes for all grout shall be designed by a Certified Concrete Mix Design Technician or
42 an engineer licensed by the State of North Carolina.

43 **1003-2 MATERIALS**

44 Refer to Division 10.

Item	Section
Chemical Admixtures	1024-3
Fine Aggregate	1014-1

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Item	Section
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Water	1024-4

- 1 Do not use grout that contains soluble chlorides or more than 1% soluble sulfate.
- 2 At the Contractor's option, use an approved packaged grout instead of the materials above
3 except for water. A list of approved packaged grouts is available from the Materials and Tests
4 Unit. Consult the manufacturer to determine if the packaged grout to be used is suitable for
5 the application and meets the height change, durability and compressive strength
6 requirements.

7 **1003-3 GROUT FOR TRAFFIC BARRIERS, FOUNDATIONS, RETAINING** 8 **WALLS, SLOPES AND OTHER APPLICATIONS**

9 **(A) Composition and Design**

10 When using approved packaged grout, a grout mix design submittal is not required.
11 Otherwise, submit proposed grout mix designs for each grout mix to be used in the work.
12 Mix proportions shall be determined by a testing laboratory approved by the Department.
13 Base grout mix designs on laboratory trial batches that meet this section.

14 Submit grout mix designs in terms of saturated surface dry weights on Materials and
15 Tests Form 312U at least 35 days before proposed use. Adjust batch proportions to
16 compensate for surface moisture contained in the aggregates at the time of batching.
17 Changes in the saturated surface dry mix proportions will not be permitted unless revised
18 grout mix designs have been submitted to the Engineer and approved.

19 Accompany Materials and Tests Form 312U with a listing of laboratory test results of
20 density, flow or viscosity and compressive strength and if applicable, aggregate
21 gradation, height change and durability. List the compressive strength of at least three
22 2" cubes at the age of 3 and 28 days.

23 The Engineer will review the grout mix design for compliance with the contract and
24 notify the Contractor as to its acceptability. Do not use a grout mix until written notice
25 has been received. Acceptance of the grout mix design or use of approved packaged
26 grouts does not relieve the Contractor of his responsibility to furnish a product that meets
27 the contract. Upon written request from the Contractor, a grout mix design accepted and
28 used satisfactorily on any Department project may be accepted for use on other projects.

29 Perform laboratory tests in accordance with the following test procedures:

Property	Test Method
Aggregate Gradation for Sand Cement Grout	AASHTO T 27
Density	AASHTO T 133
Flow for Sand Cement Grout	ASTM C939 ^A
Viscosity for Neat Cement Grout	ANSI/API RP ^B 13B-1 Section 6.2, Marsh Funnel
Height Change for Nonshrink Grout	ASTM C1090 ^C
Durability for Freeze-Thaw Durable Grout	ASTM C666 ^D
Compressive Strength	AASHTO T 106

- 30 **A.** Modify flow cone outlet diameter from 1/2" to 3/4"
- 31 **B.** American National Standards Institute/American Petroleum Institute Recommended
32 Practice
- 33 **C.** Moist room storage required
- 34 **D.** Procedure A (Rapid Freezing and Thawing in Water) required

1 (B) Chemical Admixtures

2 Use a quantity of chemical admixture within the range shown on the current list of
3 approved admixtures issued by the Materials and Tests Unit.

4 (C) Strength of Grout

5 Provide grout with a compressive strength at 3 and 28 days of at least 2,500 psi and
6 4,500 psi, respectively, unless required otherwise in the *Standard Specifications*. The
7 compressive strength of the grout will be considered the average compressive strength
8 test results of three 2" cubes at each age. Make cubes that meet AASHTO T 106 from the
9 grout delivered for the work or mixed on-site. Make cubes at such frequencies as the
10 Engineer may determine and cure them in accordance with AASHTO T 106.

11 (D) Height Change

12 Provide nonshrink grout with a height change at 28 days between 0% and 0.3%.

13 (E) Durability

14 Provide freeze-thaw durable grout with a durability factor of at least 80.

15 (F) Temperature Requirements

16 The grout temperature at the time of placement shall be not less than 50°F nor more
17 than 90°F. Do not place grout when the air temperature measured at the location of the
18 grouting operation in the shade away from artificial heat is below 40°F.

19 (G) Elapsed Time for Placing Grout

20 Agitate grout continuously before placement. Regulate the delivery so the maximum
21 interval between the placing of batches at the work site does not exceed 20 minutes.
22 Place grout before exceeding the times in Table 1003-1. Measure the elapsed time as the
23 time between adding the mixing water to the grout mix and placing the grout.

TABLE 1003-1 ELAPSED TIME FOR PLACING GROUT (with continuous agitation)		
Air or Grout Temperature, Whichever is Higher	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below	60 minutes	1 hr. 45 minutes

24 (H) Mixing and Delivery

25 Use grout free of any lumps and undispersed cement. Comply with Articles 1000-9
26 through 1000-12 to the extent applicable for grout instead of concrete.

27 **SECTION 1005**
28 **GENERAL REQUIREMENTS FOR AGGREGATE**

29 1005-1 GENERAL

30 Obtain aggregates from sources participating in the Department's Aggregate QC/QA Program
31 as described in Section 1006. Obtain aggregates from pre-approved sources, or have the
32 source approved before use. Approval of such sources is based not only on the quality of the
33 aggregate, but also on satisfactory production facilities and procedures. A list of approved
34 aggregate sources participating in the Department's Aggregate QC/QA Program in

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1 North Carolina and adjoining states is available from the Materials and Tests Unit. This list
2 includes aggregates meeting Specification requirements but whose use is restricted due to
3 history of unsatisfactory service performance. Use of aggregates is allowed in the work
4 provided they have been properly stockpiled in units of not less than 300 tons, tests of
5 representative samples of these aggregates indicate satisfactory compliance with the
6 Specifications and the source meets all the requirements of the Aggregate QC/QA Program.

7 Separate aggregate containing rock of more than one identifiable rock type or particles of
8 visibly different degrees of weathering in amounts of 10% or more into each individual type.
9 Aggregate is acceptable only if each type does not exceed the percentage of wear specified for
10 a particular use.

11 Blended aggregates from different sources are allowed if all aggregates meet the
12 Specifications for soundness or resistance to abrasion.

13 **1005-2 HANDLING AND STORING AGGREGATES**

14 Handle and stockpile aggregates in such a manner to minimize segregation.

15 Provide sites for aggregate stockpiles that are cleared, grubbed and cleaned with a firm,
16 smooth and well drained ground surface. Maintain a cover of at least 3" of aggregate over the
17 ground surface to avoid the inclusion of soil or foreign material. Operate trucks or other
18 equipment on a stockpile in an acceptable manner.

19 Space or separate with suitable walls or partitions stockpiles of different types or sizes of
20 aggregates to prevent the mixing of the aggregates. Identify stockpiles with signs that can be
21 read from a distance of at least 50 ft from the pile.

22 Do not allow the stockpile to become contaminated with foreign matter or degrade
23 excessively. Failure of aggregate samples to meet all gradation requirements due to excessive
24 degradation will be determined by sieve tests of samples taken from any portion of the
25 stockpile and is cause for discontinuance of such stockpiling procedure.

26 Use material that consists mainly of rock dust produced through normal handling of the
27 aggregate and that is essentially free from clay or shale.

28 **1005-3 GRADATION**

29 Grade all standard sizes of aggregate to meet Tables 1005-1 or 1005-2.

30 **1005-4 TESTING**

31 Aggregates will be tested in accordance with the test methods below except where other test
32 procedures are required by other articles covering a particular application.

Property	Test Method
Gradation	AASHTO T 27 and T11, AASHTO T 88 as Modified for Base Course and Stabilizer
Liquid Limit	AASHTO T 89 as Modified
Plasticity Index	AASHTO T 90
Resistance to Abrasion (Percentage of Wear)	AASHTO T 96
Soundness	AASHTO T 104 Using Sodium Sulfate

33 Copies of modified test procedures are available from the Materials and Tests Unit.

**TABLE 1005-1
AGGREGATE GRADATION - COARSE AGGREGATE**

Percentage of Total by Weight Passing													
Std. Size #	2"	1 1/2"	1"	3/4"	1/2"	#4	#8	1/2"	#10	#16	#40	#200	Remarks
4	100	90-100	20-55	0-15	-	-	-	-	-	-	-	0-0.6 ^A	Asphalt Plant Mix
467M	100	95-100	-	35-70	-	0-5	-	-	-	-	-	0-0.6 ^A	Asphalt Plant Mix
5	-	100	90-100	20-55	0-10	-	-	0-10	-	-	-	0-0.6 ^A	AST Mat Coat, Sediment Control Stone
57	-	100	95-100	-	25-60	0-10	0-5	25-60	-	-	-	0-0.6 ^A	AST, Str. Conc., Shoulder Drain, Sediment Control Stone
57M	-	100	95-100	-	25-45	0-10	0-5	25-45	-	-	-	0-0.6 ^A	AST, Portland Cement
6M	-	-	100	90-100	20-55	0-8	-	20-55	-	-	-	-	AST, Concrete Pavement
67	-	-	100	90-100	-	0-10	0-5	-	-	-	-	0-0.6 ^A	AST
78M	-	-	-	100	98-100	20-45	0-15	98-100	-	-	-	0-0.6 ^A	AST, Str. Conc., Drilled Piers, Asphalt Plant Mix
14M	-	-	-	-	-	35-70	5-20	-	-	0-8	-	0-0.6 ^A	Asphalt Plant Mix, AST, Weep Hole Drains, Str. Concrete
9	-	-	-	-	-	85-100	10-40	-	-	0-10	-	0-0.6 ^A	AST
ABC	-	100	75-97	-	55-80	35-55	-	55-80	25-45	-	14-30	4-12 ^B	-
ABC (M)	-	-	-	-	100	5-40	0-20	100	-	0-10	-	0-2.5 ^B	Aggregate Stabilization, Aggregate/Base Course, Asphalt Plant Mix
Light-weight	-	100	75-100	-	45-79	20-40	-	45-79	0-25	-	-	0-12	AST

A. See Subarticle 1005-4(A).

B. See Subarticle 1005-4(B).

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- 1 (A) When aggregates are used for Portland cement concrete, asphalt treatment and asphalt
 2 plant mix, the requirements pertaining to material passing the No. 200 sieve are as
 3 follows:
- 4 (1) When tested during production, the amount of material passing the No. 200 sieve
 5 shall be no greater than 0.6%. When tested in a stockpile at the quarry site, the
 6 amount of material passing the No. 200 sieve shall be no greater than 1.0%.
- 7 (2) When tested at the job site before use, the amount of material passing the
 8 No. 200 sieve shall:
- 9 (a) Be no greater than 1.5% for aggregate used in Portland cement concrete or
 10 asphalt surface treatment.
- 11 (b) Be no greater than 2.0% for aggregate used in asphalt plant mix.
- 12 (3) If a stockpile at the job site is found to contain in excess of the specified amount of
 13 material passing the No. 200 sieve before use, the Engineer may approve its use
 14 provided:
- 15 (a) For aggregate used in Portland cement concrete, the total percentage by weight
 16 passing the No. 200 sieve in the combined coarse and fine aggregate in the mix
 17 does not exceed 2.0%, and provided no increase in water-cement ratio is
 18 required by the use of this aggregate.
- 19 (b) For aggregate used in asphalt plant mix, the total percentage by weight of minus
 20 No. 200 material in the plant mix being produced, as determined by the
 21 extraction test, can be maintained within the limits allowed by the job mix
 22 formula.
- 23 (B) For ABC and ABC(M), in addition to the gradation requirements, the material passing
 24 the No. 40 sieve shall not have a LL in excess of 30 nor a PI in excess of 6. For ABC
 25 used in asphalt plant mix, when tested during production, in a stockpile at the quarry site
 26 or at the job site before use, the amount of material passing the No. 200 sieve shall be
 27 from 0.0% to 12.0% by weight and the gradation requirements for material passing the
 28 No. 10 sieve (soil mortar) required in Section 1010 for ABC will not apply. For ABC not
 29 used in asphalt plant mix, the gradation requirements for material passing the
 30 No. 10 sieve (soil mortar) will be as required in Section 1010.

TABLE 1005-2									
AGGREGATE GRADATION FINE AGGREGATE									
Std. Size #	Percentage of Total by Weight Passing								Remarks
	3/8"	#4	#8	#16	#30	#50	#100	#200	
1S	100	90- 100		40- 85		0-20		0-3	Blotting Sand, Asphalt Retreatment
2S	100	95- 100	80- 100	45- 95	25- 75	5-30	0-10	0-3	Concrete, Shotcrete, Grout, Subsurface Drainage, Blotting Sand
2MS		95- 100	80- 100	45- 95	25- 75	5-35	0-20	0-8 ^A	Concrete, Shotcrete, Grout, Subsurface Drainage
4S		100	95- 100			15- 45	0-10	0-5	Mortar

- 31 A. When tested at the job site before use, the amount of material passing the
 32 No. 200 sieve shall not be greater than 10%.

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SECTION 1006

AGGREGATE QUALITY CONTROL/QUALITY ASSURANCE

The Aggregate QC/QA Program is designed to give aggregate producers more responsibility for controlling the quality of material they produce and to use the quality control information they provide in the acceptance process by the Department. It requires aggregate producers to perform quality control sampling, testing and record keeping on aggregates they ship for use by the Department. It requires the Department to perform quality assurance sampling, testing and record keeping confirming the performance of the producers' control plan. The program is described in the *Aggregate QC/QA Program Manual*.

Participation in this program does not relieve the producer of the responsibility of complying with all requirements of the Department's *Standard Specifications*.

SECTION 1008

AGGREGATE FOR STABILIZATION

1008-1 AGGREGATE STABILIZATION

(A) General

Aggregates consist of crushed stone, crushed gravel, uncrushed gravel or other similar material having hard, strong, durable particles free of adherent coatings.

Supply aggregates from approved sources participating in the Department's Aggregate QC/QA Program in accordance with Sections 1005 and 1006. Sources will not be approved unless the material has satisfactory soundness and satisfactory resistance to abrasion. Satisfactory soundness will be a loss in weight of not greater than 15% when subject to 5 alternations of the soundness test. Satisfactory resistance to abrasion will be a percentage of wear of not greater than 55%.

(B) Sampling and Acceptance

Sampling and acceptance for the determination of gradation, LL and PI will be performed as described in the *Aggregate QC/QA Program Manual* and the *Aggregate Sampling Manual* using the versions in effect at the time material is shipped.

SECTION 1010

AGGREGATE FOR NON-ASPHALT TYPE BASES

1010-1 AGGREGATE BASE COURSE

(A) General Requirements

Aggregate base course material consists of crushed stone, crushed gravel, uncrushed gravel or other similar material having hard, strong, durable particles free of adherent coatings.

Provide aggregates from approved sources participating in the Department's Aggregate QC/QA Program in accordance with Sections 1005 and 1006. Sources will not be approved unless the material has satisfactory soundness and resistance to abrasion. Satisfactory soundness will be a weighted average loss of not greater than 15% when subjected to 5 alternations of the soundness test. Satisfactory resistance to abrasion will be a percentage of wear of not greater than 55%.

(B) Sampling and Acceptance

Sampling and acceptance for the determination of gradation, LL and PI will be performed as described in the *Aggregate QC/QA Program Manual* and the *Aggregate Sampling Manual* using the versions in effect at the time material is shipped.

Section 1012

1 **1010-2 AGGREGATE FOR PLANT MIXED CEMENT TREATED BASE COURSE**

2 Provide aggregate meeting Article 1010-1, except as modified herein. Sources of aggregate
3 will not be approved unless the material has a percentage of wear of not greater than 65%.

4 **SECTION 1012**
5 **AGGREGATE FOR ASPHALT PAVEMENTS**
6 **AND SURFACE TREATMENTS**

7 **1012-1 AGGREGATE FOR ASPHALT PLANT MIXES**

8 **(A) General**

9 Design the asphalt plant mix with coarse and fine aggregate that meet Section 1005,
10 except as noted herein. Size, uniformly grade and combine the aggregate fractions in
11 such proportions that the resulting mixture meets the grading and physical requirements
12 of these Specifications for the specified mix type. Materials that will not produce
13 a mixture within the design criteria required by these Specifications will be rejected,
14 unless otherwise approved.

15 The consensus property criteria in Table 1012-1 apply to the design aggregate blend.
16 Source property criteria apply to individual aggregate sources.

17 For all dense-graded surface course mixes, that are the top or final layer, limit the amount
18 of coarse aggregate or fine aggregate produced from crystalline limestone, crystalline-
19 dolomitic limestone or marble to no more than 50% of the total amount of coarse
20 aggregate or fine aggregate in the asphalt mixture. For open-graded asphalt friction
21 course and ultra-thin bonded wearing course, do not use aggregates produced from
22 crystalline limestone, crystalline-dolomitic limestone or marble.

23 **(B) Coarse Aggregate**

24 (1) General

25 Use coarse aggregate consisting of crushed stone, crushed gravel, a mixture of
26 uncrushed gravel with either crushed stone or crushed gravel or other inert material
27 having similar characteristics. Provide coarse aggregate composed of clean, tough,
28 durable fragments free from an excess of flat or elongated pieces and free of organic
29 matter and deleterious substances.

30 Use coarse aggregate from sources participating in the Department's Aggregate
31 QC/QA Program as described in Section 1006. A list of sources participating in the
32 Department's Aggregate QC/QA Program in North Carolina and adjoining states is
33 available from the Materials and Tests Unit in Raleigh.

34 (2) Gradation

35 Use standard size coarse aggregate meeting Table 1005-1 and these *Standard*
36 *Specifications* unless otherwise approved.

37 (3) Coarse Aggregate Angularity (Fractured Faces)

38 Use coarse aggregate meeting Table 1012-1 for coarse aggregate angularity
39 (fractured faces) when tested in accordance with ASTM D5821.

40 (4) Flat and Elongated Pieces

41 Use coarse aggregate meeting Table 1012-1 for flat and elongated pieces when tested
42 in accordance with ASTM D4791 on the No. 4 sieve and larger with a 5:1 aspect
43 ratio (maximum to minimum) for all pavement types, except there is no requirement
44 for Types SF9.5A and S9.5B.

(5) Soundness

The maximum weighted average soundness loss of individual coarse aggregate sources when subjected to 5 cycles using sodium sulfate when tested in accordance with AASHTO T 104 is 15%.

Mix Type	Coarse Aggregate Angularity ^B	Fine Aggregate Angularity % Minimum	Sand Equivalent % Minimum	Flat and Elongated 5 : 1 Ratio % Maximum
<i>Test Method</i>	<i>ASTM D5821</i>	<i>AASHTO T 304</i>	<i>AASHTO T 176</i>	<i>ASTM D4791</i>
SF9.5A; S9.5B	75 / -	40	40	-
I19.0B; B25.0B	75 / -	40	40	10
S9.5C; S12.5C; I19.0C; B25.0C	95 / 90	45	45	10
S9.5D; S12.5D; I19.0D	100 / 100	45	50	10
OGAFC	100 / 100	45	45	10
UBWC	100 / 85	45	45	10

A. Requirements apply to the design aggregate blend.

B. 95/90 denotes that 95% of the coarse aggregate has one fractured face and 90% has 2 or more fractured faces.

(6) Toughness (Resistance to Abrasion)

The maximum allowable percentage of loss of each individual coarse aggregate source for all plant mix types except open-graded asphalt friction course, shall be 55% when tested in accordance with AASHTO T 96. The maximum percentage loss for aggregate used in OGAFC shall be 45%. The percentage loss for aggregate used in UBWC shall be no more than 35%.

(7) Deleterious Materials

The maximum allowable percentage by weight of clay lumps and friable particles in individual aggregate sources shall be 0.3% when tested in accordance with AASHTO T 112.

(8) Durability (Micro-Deval test)

The maximum allowable abrasion loss for aggregate used in UBWC shall be 18% when tested in accordance with AASHTO T 327.

(C) Fine Aggregate

(1) General

Use fine aggregate that is consistently graded from coarse to fine and consists of natural sand, stone screenings, or a blend of natural sand and stone screenings. Use aggregate composed of rough surfaced and angular grains of quartz or other hard durable rock.

Section 1012

1 Use fine aggregate from sources participating in the Department's Aggregate
2 QC/QA Program as described in Section 1006. A list of sources participating in the
3 Department's QC/QA Program in North Carolina and adjoining states is available
4 from the Department's Materials and Tests Unit in Raleigh. If a natural sand source
5 is owned by the same owner as the asphalt plant where the material is used,
6 participation in the Aggregate QC/QA Program is not required.

7 Furnish sand from approved sources. Do not use sources contaminated by industrial
8 waste. A sufficient number of samples of fine aggregate, but in no case less than 3,
9 will be taken to indicate any variation within any stockpile or source of supply.

10 Do not use fine aggregate containing sticks, roots, trash, visible lumps of clay, or
11 other unsatisfactory material unless all undesirable material is removed to the
12 satisfaction of the Engineer before the aggregate is used in the asphalt mixture.

13 Use natural sand that is non-plastic when tested in accordance with AASHTO T 90.

14 Produce stone screenings from stone that has a maximum percentage of wear of 55%
15 when tested in accordance with AASHTO T 96 using test grading A.

16 (2) Gradation

17 Use stone screenings that are consistently graded with not more than 20% by weight
18 passing the No. 200 sieve when tested by dry sieving in accordance with
19 AASHTO T 27. Use natural sand that is consistently graded.

20 (3) Clay Content (Sand Equivalent)

21 Use a fine aggregate blend that has a minimum sand equivalent percentage as
22 indicated in Table 1012-1 when tested in accordance with AASHTO T 176.

23 (4) Soundness

24 The maximum weighted average soundness loss of individual fine aggregate sources
25 when subjected to 5 cycles using sodium sulfate shall be 15% when tested in
26 accordance with AASHTO T 104.

27 Natural sand that contains grains of questionable hardness will be subjected to
28 5 cycles of the soundness test. The weighted average loss shall be not more
29 than 15%. The soundness test will be performed before establishing the mix design.

30 (5) Deleterious Materials

31 The maximum percentage by weight of clay lumps and friable particles in individual
32 fine aggregate sources shall be 0.3% when tested in accordance with
33 AASHTO T 112.

34 (6) Fine Aggregate Angularity

35 Use a fine aggregate blend that has a minimum fine aggregate angularity as indicated
36 in Table 1012-1 when tested in accordance with AASHTO T 304, Method A.

37 (D) Mineral Filler

38 Use mineral filler consisting of limestone dust, dolomite dust, Portland cement, or other
39 inert mineral matter that conforms to AASHTO M 17.

40 (E) Reclaimed Asphalt Shingles (RAS)

41 For use in asphalt mix, Reclaimed Asphalt Shingles (RAS) can be either manufacturer-
42 waste shingles or post-consumer shingles that have been processed into a product that
43 meets the requirements of this section.

1 Manufacturer-waste RAS (MRAS) are processed shingle materials discarded from the
2 manufacturing of new asphalt shingles. It may include asphalt shingles or shingle tabs
3 that have been rejected by the shingle manufacturer.

4 Post-consumer RAS (PRAS) are processed shingle materials recovered from mixed
5 roofing material scrap removed from existing structures. Tear-off shingle scrap must be
6 sorted and other roofing debris, including nails, plastic, metal, wood, coal tar epoxy,
7 rubber materials, or other undesirable components, shall be removed. This sorting of the
8 scrap must be done prior to grinding of the PRAS for use in asphalt production.

9 Sample and test PRAS for asbestos and provide results demonstrating that the bulk
10 samples contain less than one percent of asbestos containing material in accordance with
11 Federal, State of North Carolina, and Local regulations. Use NC-accredited Asbestos
12 Inspectors or Roofing Supervisors to sample the PRAS to meet the above criteria.
13 Maintain records on-site indicating shingle source(s), asbestos operation plan approved
14 by Division of Public Health's Health Hazards Control Unit, and all asbestos analytical
15 reports. All documentation will be subject to review by the Department.

16 Process RAS by ambient grinding or granulating methods such that 100% of the particles
17 will pass the 9.50 mm (3/8") sieve when tested in accordance with AASHTO T27.
18 Perform sieve analysis on processed asphalt shingles prior to ignition or solvent
19 extraction testing.

20 RAS shall contain no more than 0.5% by total cumulative weight of deleterious materials.
21 These materials include, but are not limited to, excessive dirt, debris, concrete, metals,
22 glass, paper, rubber, wood, plastic, soil, brick, tars, or other contaminating substances.

23 Blend RAS with fine aggregate or RAP, meeting the requirements of this Section, if
24 needed to keep the processed material workable.

25 MRAS and PRAS shall not be blended together for the production of hot mix asphalt.

26 (1) Mix Design RAS

27 Incorporate RAS from stockpiles that have been tested for uniformity of gradation
28 and binder content prior to use in an asphalt mix design.

29 (2) Mix Production RAS

30 New Source RAS is defined as acceptable material which was not included in the
31 stockpile when samples were taken for mix design purposes. Process new source
32 RAS so that all materials will meet the gradation requirements prior to introduction
33 into the plant mixer unit.

34 After a stockpile of processed RAS has been sampled and mix designs made from
35 these samples, do not add new source RAS to the original stockpile without prior
36 field testing to insure gradation and binder uniformity. Sample and test new source
37 RAS before blending with the existing stockpile.

38 Store new source RAS in a separate stockpile until the material can be sampled and
39 tested for comparison with the original recycled mix design data. New source RAS
40 may also be placed against the existing stockpile in a linear manner provided it is
41 sampled for mix design conformity prior to its use in the recycled mix. Store RAS
42 materials in such a manner as to prevent contamination.

43 Field approval of new source RAS will be based on the table below and volumetric
44 mix properties on the mix with the new source RAS included. Provided these
45 tolerances are met, volumetric properties of the new mix will then be performed. If
46 all volumetric mix properties meet the mix design criteria for that mix type, the new
47 source RAS may continue to be used.

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1 If the gradation, binder content, or any of the volumetric mix properties are not
2 within the allowable tolerances of the table below, do not use the new source RAS
3 unless approved by the Engineer. The Contractor may elect to either not use the
4 stockpile, to request an adjustment to the JMF, or to redesign the mix.

TABLE 1012-2 NEW SOURCE RAS BINDER AND GRADATION TOLERANCES (Apply Tolerances to Mix Design Data)	
P_b %	± 2.5
<i>Sieve Size, mm</i>	<i>Tolerance</i>
4.75	± 5
2.36	± 4
1.18	± 4
0.300	± 4
0.150	± 4
0.075	± 2.0

5 (F) Reclaimed Asphalt Pavement (RAP)

6 (1) Mix Design RAP

7 Incorporate RAP from stockpiles or other sources tested for uniformity of gradation
8 and binder content before use in an asphalt mix design. Use RAP that meets all
9 requirements specified for the following classifications.

10 (a) Millings

11 Existing RAP that is removed from its original location by a milling process as
12 specified in Section 607. Millings should be such that it has a uniform gradation
13 and binder content and all materials will pass a 2" sieve before introduction into
14 the plant mixer unit.

15 (b) Processed RAP

16 RAP that is processed in some manner (possibly by crushing and/or use of
17 a blending method) to produce a uniform gradation and binder content in the
18 RAP before use in a recycled mix. Process RAP so all materials have a uniform
19 gradation and binder content and will pass a 1" sieve before introduction into the
20 plant mixer unit.

21 (c) Fractionated RAP

22 Fractionated RAP is defined as having 2 or more RAP stockpiles, where the
23 RAP is divided into coarse and fine fractions. Grade RAP so all materials will
24 pass a 1" sieve. The coarse RAP stockpile shall only contain material retained
25 on a 3/8" screen, unless otherwise approved. The fine RAP stockpile shall only
26 contain material passing the 3/8" screen, unless otherwise approved. The
27 Engineer may allow the Contractor to use an alternate to the 3/8" screen to
28 fractionate the RAP. The maximum percentages of fractionated RAP may be
29 comprised of coarse, fine, or the combination of both. Use a separate cold feed
30 bin for each stockpile of fractionated RAP introduced into the mix.

31 (d) Approved Stockpiled RAP

32 Approved Stockpiled RAP is defined as fractionated RAP which has been
33 isolated and tested for asphalt content, gradation and asphalt binder
34 characteristics with the intent to be used in mix designs with greater than
35 30% RAP materials. Fractionate the RAP in accordance with
36 Subsection 1012-1(F)(1)(c). Use a separate cold feed bin for each approved
37 stockpile of RAP used.

1 Perform extraction tests at a rate of one per 1,000 tons of RAP, with at least
 2 5 tests per stockpile to determine the asphalt content and gradation. Separate
 3 stockpiles of RAP material by fine and coarse fractions. Erect and maintain
 4 a sign satisfactory to the Engineer on each stockpile to identify the material.
 5 Assure that no deleterious material is allowed to contaminate any stockpile. The
 6 Engineer may reject by visual inspection any stockpiles that are not kept clean,
 7 separated and free of foreign materials.

8 Submit requests for RAP stockpile approval to the Engineer with the following
 9 information at the time of the request:

- 10 (i) Approximate tons of materials in stockpile,
 11 (ii) Name or Identification number for the stockpile,
 12 (iii) Asphalt binder content and gradation test results, and
 13 (iv) Asphalt characteristics of the stockpile.

14 For the Stockpiled RAP to be considered for approval, the gradation and asphalt
 15 content shall be uniform. Individual test results, when compared to the target,
 16 will be accepted if within the tolerances listed in Table 1012-3.

P_b %	± 0.3%
<i>Sieve Size, mm</i>	<i>Tolerance</i>
25.0	± 5%
19.0	± 5%
12.5	± 5%
9.50	± 5%
4.75	± 5%
2.36	± 4%
1.18	± 4%
0.300	± 4%
0.150	± 4%
0.075	± 1.5%

17 **A.** If more than 20% of the individual sieves are out of the gradation
 18 tolerances, or if more than 20% of the asphalt binder content test results fall
 19 outside the appropriate tolerances, the RAP shall not be used in HMA
 20 unless the RAP representing the failing tests is removed from the stockpile.

21 Do not add additional material to any approved RAP stockpile, unless
 22 otherwise approved by the Engineer.

23 Maintain a record system for all approved RAP stockpiles at the plant site.
 24 Include at a minimum the following: Stockpile identification and a sketch
 25 of all stockpile areas at the plant site; all RAP test results (including asphalt
 26 content, gradation and asphalt binder characteristics).

27 (2) Mix Production RAP

28 During mix production, use RAP that meets the criteria for one of the following
 29 categories:

30 (a) Mix Design RAP

31 RAP contained in the mix design stockpiles as described above may be used in
 32 all applicable JMFs. These stockpiles have been pretested; however, they are
 33 subject to required QC/QA testing in accordance with the *HMA/QMS Manual*.

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(b) New Source RAP

Define “new source RAP” as any acceptable material that was not included in the stockpile or other source when samples were taken for mix design purposes. Process new source RAP so all materials have a uniform gradation and binder content and will pass a 2" sieve before introduction into the plant mixer unit.

**TABLE 1012-4
NEW SOURCE RAP GRADATION AND BINDER TOLERANCES
(Apply Tolerances To Mix Design Data)**

	0 - 20% RAP			20 - 30 % RAP			> 30 % RAP		
Pb, %	± 0.7%			± 0.4%			± 0.3%		
Sieve Size, mm	Mix Type			Mix Type			Mix Type		
	Base	Inter.	Surf.	Base	Inter.	Surf.	Base	Inter.	Surf.
25.0	±10	-	-	±7	-	-	±5	-	-
19.0	±10	±10	-	±7	±7	-	±5	±5	-
12.5	-	±10	±6	-	±7	±3	-	±5	±2
9.50	-	-	±8	-	-	±5	-	-	±4
4.75	±10	-	±10	±7	-	±7	±5	-	±5
2.36	±8	±8	±8	±5	±5	±5	±4	±4	±4
1.18	±8	±8	±8	±5	±5	±5	±4	±4	±4
0.300	±8	±8	±8	±5	±5	±5	±4	±4	±4
0.150	-	-	±8	-	-	±5	-	-	±4
0.075	±4	±4	±4	±2	±2	±2	±1.5	±1.5	±1.5

After a stockpile of millings, processed RAP or fractionated RAP has been sampled and mix designs made from these samples, do not add new source RAP to the original stockpile without prior field testing to insure gradation and binder uniformity. Sample and test new source RAP before blending with the existing stockpile.

Store new source RAP in a separate stockpile until the material can be sampled and tested for comparison with the original recycled mix design data. New source RAP may also be placed against the existing stockpile in a linear manner provided it is sampled for mix design conformity before its use in the recycled mix.

Unprocessed RAP is asphalt material that was not milled and/or has not been processed to obtain a uniform gradation and binder content and is not representative of the RAP used during the applicable mix design. Unprocessed RAP shall not be incorporated into any JMFs before processing. Different sources of unprocessed RAP may be stockpiled together provided it is generally free of contamination and will be processed before use in a recycled mix. RAP contamination in the form of excessive dirt, debris, clean stone, concrete, etc. will not be allowed. Incidental amounts of dirt, concrete and clean stone may be acceptable. Unprocessed RAP may be processed and then classified as a new source RAP as described above.

Field approval of new source RAP will be based on Table 1012-4 and volumetric mix properties on the mix with the new source RAP included. Provided the Table 1012-4 tolerances are met, volumetric properties of the new mix will then be performed. If all volumetric mix properties meet the mix design criteria for that mix type, the new source RAP may continue to be used.

If the gradation, binder content, or any of the volumetric mix properties are not within the allowable tolerances of Table 1012-4, do not use the new source RAP unless approved by the Engineer. The Contractor may elect to either not use the stockpile, to request an adjustment to the JMF, or to redesign the mix.

(G) Anti-Strip Additives

Anti-strip additives may either be hydrated lime or a chemical additive or a combination of both. Use an anti-strip additive capable of preventing the separation of the asphalt binder from the aggregate and achieving the required tensile strength ratio (TSR) on the asphalt mix when tested in accordance with AASHTO T 283 as modified by the Department.

Use hydrated lime conforming to AASHTO M 303. Add hydrated lime used of anti-strip purposes at a rate of not less than 1.0% by weight of the total dry aggregate.

Add chemical anti-strip additives to the asphalt binder before introduction into the mix. Do not use any chemical additive or particular concentration of chemical additive found to be harmful to the asphalt material or which causes the performance grading of the original asphalt binder to be out of specifications for the grade required.

(H) Silicone

Silicone additives shall be pre-approved by the Materials and Tests Unit.

(I) Fiber Stabilizing Additives

Use fiber stabilizing additives that are capable of stabilizing the asphalt film surrounding the aggregate particles to reduce drain-down of the asphalt binder. A fiber stabilizer such as mineral fiber or cellulose may be used. The selected fiber shall meet the properties described below. Dosage rates given are typical ranges but the actual dosage rate used will be approved by the Engineer.

(1) Mineral Fibers

Mineral fibers shall be made from virgin basalt, diabase or slag treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the fiber surface to the asphalt binder. Mineral fibers shall be in accordance with Table 1012-5. Add the fiber at a dosage rate between 0.2% and 0.4% by weight of total mix, as approved.

Property	Requirement	Test Method
Average Fiber length	0.25" maximum	-
Average Fiber thickness	0.0002" maximum	-
Shot Content Passing No. 60 sieve	90 - 100%	ASTM C612
Shot Content Passing No. 230 sieve	65 - 100%	ASTM C612
Degradation	30% maximum	GDT-124/McNett Fractionation

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(2) Cellulose Fibers

Add cellulose fibers at a dosage rate between 0.2% and 0.4% by weight of total mix as approved. Fiber properties shall be in accordance with Table 1012-6.

Property	Requirement
Average Fiber Length	0.25" maximum
Alpine Sieve Method Passing No. 100 Sieve	60 - 80%
Ro-Tap Sieve Method Passing No. 20 Sieve	80 - 95%
Ro-Tap Sieve Method Passing No. 40 Sieve	45 - 85%
Ro-Tap Sieve Method Passing No. 100 Sieve	5 - 40%
Ash Content	18% ± 5% non-volatiles
pH	7.5 ± 1
Oil Absorption	5.0 ± 1 (times fiber weight)
Moisture Content	5.0 maximum

(3) Cellulose Pellets

Cellulose pellets consist of a 50/50 blend of cellulose fiber and asphalt binder. Use cellulose that complies with Subarticle 1012-1(I)(2) and Table 1012-7. Add the cellulose pellets at a dosage rate between 0.4% and 0.8% by weight of total mix, as approved.

Property	Requirement
Pellet Size	1/4 cu.in. maximum
Asphalt	25 - 80 pen.

1012-2 AGGREGATES FOR ASPHALT SURFACE TREATMENT

(A) General

Use coarse aggregate consisting of crushed stone, crushed gravel, crushed slag, or other inert material having similar characteristics. Adequately wash coarse aggregate so it is free from clay, loam, dust and other adherent materials.

Adequately clean all fine aggregate so it is free from sticks, roots, visible lumps of clay or other unsatisfactory material before use.

(B) Gradation

Use coarse aggregate for mat and seal coat and AST as required by Table 660-1, unless otherwise required by the contract. Use aggregate meeting the applicable gradation requirements of Table 1005-1.

Remix aggregate that has become segregated until it meets the applicable gradation requirements.

(C) Fractured Faces

Use coarse aggregate that contains at least 75% by weight of crushed pieces having 2 or more fractured faces and at least 90% by weight of crushed pieces having one or more fractured faces on that portion retained on the No. 4 sieve.

(D) Soundness

The maximum weighted average loss of either coarse or fine aggregate when subjected to 5 cycles using sodium sulfate when tested in accordance with AASHTO T 104 is 15%.

(E) Toughness (Resistance to Abrasion)

The maximum percentage loss of course aggregate for asphalt surface treatment when tested in accordance with AASHTO T 96 is 55%.

(F) Blending of Aggregates

Blending of 2 or more aggregates will not be permitted regardless of the origin of the aggregates if any one of the aggregates fails to meet the requirements for soundness or resistance to abrasion.

(G) Weight of Slag

The minimum weight of crushed slag is 70 lb/cf as determined in accordance with AASHTO T 19.

1012-3 BLOTTING SAND

Blotting sand is fine aggregate consisting of natural sand, commercial sand, manufactured sand, coarse screenings, or other inert material having similar characteristics. Subarticles 1012-2(D) and 1012-2(F) will be applicable to blotting sand. Adequately clean the fine aggregate so it is free from sticks, roots, visible lumps of clay or other unsatisfactory material before use.

1012-4 LIGHTWEIGHT AGGREGATE

Lightweight aggregates used in asphalt surface treatments shall be produced by the rotary kiln process and shall come from an approved Department source meeting applicable requirements of Section 1005 and 1006. The aggregate shall meet Table 1012-8 and AASHTO M 195 with the exception of Sections 3, 6, 8 and any other references to concrete samples or concrete strength.

TABLE 1012-8 LIGHTWEIGHT AGGREGATE PHYSICAL PROPERTIES		
Property	Specification (maximum limit)	Test Method
Sodium Sulfate Soundness	5%	AASHTO T 104
Los Angeles Abrasion	45%	AASHTO T 96 (B grading)
Percent Absorption	10%	AASHTO T 19
Micro-Deval	18%	AASHTO T 327

SECTION 1014**AGGREGATE FOR PORTLAND CEMENT CONCRETE****1014-1 FINE AGGREGATE****(A) General**

Use fine aggregate from sources participating in the Department's Aggregate QC/QA Program as described in Section 1006. A list of sources participating in the Department's QC/QA Program in North Carolina and adjoining states is available from the Materials and Tests Unit.

Use fine aggregate consisting of natural sand or manufactured sand having clean, durable, hard, uncoated particles, or other inert materials having similar characteristics. Produce manufactured sand from fractured stone material. Use fine aggregate free from dirt, wood, paper, burlap and all other foreign material.

To permit excess water to drain and the moisture content to become uniform, stockpile the aggregates either at the producer's plant or at the batch plant site for at least 24 hours before use in the concrete. Build open stockpiles of fine aggregate at the batch plant on concrete surfaces. Do not add new material to the stockpile during the 24 hour period.

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1 When the aggregates have a low and uniform moisture content and the consistency of the
2 concrete can be satisfactorily controlled without stockpiling the aggregates for 24 hours,
3 the minimum stockpiling period may be reduced or waived entirely by the Engineer.

4 The Department's list of approved sources of fine aggregate shows the target fineness
5 modulus of each aggregate as established by the producer. Do not use fine aggregate
6 with a fineness modulus that varies more than 0.2 from the target value until the concrete
7 mix proportions are adjusted.

8 **(B) Soundness**

9 When subjected to 5 cycles of the soundness test, the weighted average loss shall not be
10 more than 15%.

11 **(C) Deleterious Substances**

12 Determine the percentage of deleterious substances (clay lumps and friable particles) in
13 accordance with AASHTO T 112. The amount of deleterious substances shall not exceed
14 2.0% by weight for natural sand or 1.0% by weight for manufactured sand.

15 **(D) Organic Impurities**

16 The color of each source of fine aggregate will be determined annually in accordance
17 with AASHTO T 21. Should the fine aggregate show a darker color than samples
18 previously approved from the same source, withhold its use until tests have been made to
19 determine the quality of the sand.

20 **(E) Mortar Strength**

21 Mortar made with the fine aggregate shall have a compressive strength at the age of
22 3 and 7 days using Type III Portland cement, or 7 and 28 days using Type I or II Portland
23 cement, of not less than 95% of that developed by a comparison mortar. Make the
24 comparison mortar with the same cement, graded Ottawa sand with a fineness modulus of
25 2.40 ± 0.05 , and the same water-cement ratio and consistency as the test mortar. Test the
26 mortar strength in accordance with AASHTO T 106.

27 Fine aggregate that fails the mortar strength may be used with the approval of the
28 Engineer, provided that when it is tested in concrete cylinders the compressive strength of
29 the concrete at 14 days is equal to or greater than the strength of cylinders made with
30 an identical mix using an acceptable sand.

31 **(F) Gradation**

32 Natural sand shall meet the gradation for standard size No. 2S fine aggregate.
33 Manufactured sand shall meet the gradation for standard size No. 2MS fine aggregate.

34 **(G) Blending Fine Aggregate**

35 Blending fine aggregates to obtain the required gradation will be permitted if test results
36 of each aggregate meet the durability requirements and test results of the combination
37 indicate acceptable quality. Blend aggregates by weighing them separately at the time of
38 batching or by other means acceptable to the Engineer.

39 When natural sand is blended with natural sand, the blend shall meet the gradation for
40 No. 2S fine aggregate. When manufactured sand is blended with natural sand or with
41 manufactured sand, the blend shall meet the gradation for No. 2MS fine aggregate and
42 neither component shall exceed the gradation limits on the No. 200 sieve shown in
43 Table 1005-2.

1 1014-2 COARSE AGGREGATE**2 (A) General**

3 Use coarse aggregate from sources participating in the Department's Aggregate QC/QA
4 Program as described in Section 1006. A list of these sources in North Carolina and
5 adjoining states is available from the Materials and Tests Unit in Raleigh.

6 Use coarse aggregate that consists of crushed stone, crushed or uncrushed gravel, crushed
7 air-cooled blast furnace slag or other inert materials that have similar characteristics.
8 Wash all coarse aggregate for Portland cement concrete to remove clay, loam, dust and
9 similar adherent materials unless otherwise permitted by the Engineer in writing. Keep
10 coarse aggregate free from dirt, wood, paper, burlap and all other foreign material.

11 To permit excess water to drain and the moisture content to become uniform, stockpile
12 the aggregates either at the producer's plant or at the batch plant site for at least 24 hours
13 before use in the concrete. Build open stockpiles of coarse aggregate at the batch plant
14 on concrete surfaces. Do not add new material to the stockpile during the 24 hour period.
15 Where the aggregates have low and uniform moisture content and the consistency of the
16 concrete can be satisfactorily controlled without stockpiling the aggregates for 24 hours,
17 the minimum stockpiling period may be reduced or waived entirely by the Engineer.

18 Do not mix coarse aggregate from different sources or use it in alternate batches except
19 where permitted by the Engineer in writing. Blending of coarse aggregates to obtain the
20 required gradation will be permitted if the different sizes are from the same source.
21 Blend coarse aggregates by weighing them separately at the time of batching or by other
22 means acceptable to the Engineer.

23 (B) Soundness

24 When subjected to 5 cycles of the soundness test, the weighted average loss shall not
25 exceed 15%. For concrete with a 28 day design compressive strength greater than
26 6,000 psi, the loss shall not exceed 8%.

27 (C) Deleterious Substances

28 Determine the percentage of deleterious substances (clay lumps and friable particles) in
29 accordance with AASHTO T 112. The amount of deleterious substances shall not exceed
30 3.2% by weight.

31 (D) Resistance to Abrasion

32 The percentage of wear of crushed stone or gravel shall not exceed 55%. For concrete
33 with a 28 day design strength greater than 6,000 psi, the wear shall not exceed 40%.

34 (E) Aggregate Sizes**35 (1) General**

36 Use standard size No. 57, No. 67, or No. 78M coarse aggregate in Portland cement
37 concrete unless otherwise indicated.

38 (2) Latex Modified Concrete

39 Use standard size No. 78M coarse aggregate in latex modified concrete.

40 (3) Prestressed and Precast Concrete

41 Use standard size No. 67 or No. 78M coarse aggregate in prestressed and precast
42 concrete.

43 (4) Use of More Than One Size

44 All concrete used in a single component of any structure shall be made with the same
45 size aggregate.

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- 1 (5) Portland Cement Concrete Pavement
- 2 Use standard size No. 57, No. 57M, No. 67 or No. 78M coarse aggregate in concrete
- 3 for Portland cement concrete pavement unless otherwise specified by the Engineer.
- 4 (6) Sand Lightweight Concrete
- 5 Use the following gradation for the lightweight coarse aggregate

TABLE 1014-1 GRADATION FOR LIGHTWEIGHT COARSE AGGREGATE	
Sieve Size	Passing Square Opening Sieves (Percent by Weight)
1"	100
3/4"	90 - 100
3/8"	10 - 50
No. 4	0 - 15

- 6 (7) Drilled Pier Concrete
- 7 Use standard size No. 78M coarse aggregate in Drilled Pier concrete.

**SECTION 1016
SELECT MATERIALS**

1016-1 DESCRIPTION

Select material is suitable material classified by gradation and performance characteristics as shown in this section. Use select material called for on the contract.

1016-2 USES

Select material may be specified for use in:

- | | |
|-------------------------|--------------------------------|
| Subgrade | Slope and shoulder embankment |
| Backfill in undercut | Rock embankment in open water |
| Core material | Material placement over fabric |
| Foundation conditioning | Pipe backfill |

With written approval and without additional compensation, a higher class of material may be substituted than stated in the contract.

1016-3 CLASSIFICATIONS

CLASS I

Class I select material is silty or clayey soil material meeting AASHTO M 145 for soil classification A-4. Soil materials which meet AASHTO M 145 for soil classifications A-2, A-5, A-6 and A-7 are acceptable provided such materials do not have a LL greater than 50, nor a PI of less than 7 or greater than 20.

CLASS II

Type 1 Select Material

Type 1 select material is a fine aggregate material consisting of crushed stone screenings (washed or unwashed) meeting the gradation in Table 1016-1.

TABLE 1016-1 GRADATION FOR CLASS II, TYPE 1 SELECT MATERIAL	
Sieve	% Passing
3/8 in	100
#4	80 - 100
#10	65 - 95
#40	25 - 55
#200	0 - 20
LL	≤ 30
PI	≤ 6

1 **Type 2 Select Material**

2 Type 2 select material is a granular soil material meeting AASHTO M 145 for soil
3 classifications A-2-4 with a maximum PI of 6 and A-4 soil containing 45% maximum passing
4 a No. 200 sieve and a maximum PI of 6.

5 When a type is not specified, either type may be used, but no additional compensation will be
6 made.

7 **CLASS III**

8 **Type 1 Select Material**

9 Type 1 select material is a natural or manufactured fine aggregate material meeting the
10 gradation requirements of standard size 2S or 2MS in Table 1005-2 as described in
11 Sections 1005 and 1006.

12 **Type 2 Select Material**

13 Type 2 select material is a granular soil material meeting AASHTO M 145 for soil
14 classification A-1 or A-3.

15 When a type is not specified, either type may be used, but no additional compensation will be
16 made.

17 **CLASS IV**

18 Select material is a coarse aggregate material meeting the gradation requirements of standard
19 size ABC as described in Section 1010.

20 **CLASS V**

21 Select material is a coarse aggregate material meeting the gradation requirements of standard
22 size 78M in Table 1005-1 as described in Section 1005 and 1006.

23 **CLASS VI**

24 Select material is a coarse aggregate material meeting the gradation requirements of standard
25 size 57 in Table 1005-1 as described in Section 1005 and 1006.

26 **Class VII**

27 Select material is clean, unweathered durable, blasted rock material with the following
28 gradation:

29 **(A)** At least 50% of the rock has a diameter of from 1.5 ft to 3 ft,

30 **(B)** 40% of the rock ranges in size from 2" to 1.5 ft in diameter, and

31 **(C)** Not more than 10% of the rock is less than 2" in diameter. No rippable rock will be
32 permitted.

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**SECTION 1018
BORROW MATERIAL**

1018-1 GENERAL

Borrow material is used for embankments, backfill or other intended uses. Material that contains roots, root mats, stumps or other unsatisfactory material will not be acceptable.

1018-2 APPROVAL OF BORROW SOURCE

The approval of borrow sources is subject to Section 230.

(A) Statewide Criteria for Acceptance of Borrow Material

See exceptions in Subarticle 1018-2(B).

Use only natural earth materials as borrow material. Any other materials are subject to rejection.

TABLE 1018-1 PIEDMONT AND WESTERN AREA CRITERIA FOR ACCEPTANCE OF BORROW MATERIAL	
Soil with PI of 25 or less	Acceptable
Soil with PI of 26 through 35	Acceptable, but not to be used in top 2 ft of embankment or backfill
Soil with PI of more than 35	Not Acceptable

(B) Exceptions to Statewide Criteria for Acceptance of Borrow Material

(1) Soils in the Coastal Plain (area described below) will be accepted in accordance with the Table 1018-2.

TABLE 1018-2 COASTAL AREA CRITERIA FOR ACCEPTANCE OF BORROW MATERIAL	
Soil with PI of 15 or less	Acceptable
Soil with PI of 16 through 20	Acceptable, but not to be used in top 2 ft of embankment or backfill
Soil with PI of more than 20	Not Acceptable

Areas where Table 1018-2 is applicable are as follows:

- Division 1 Entire Division except Northampton (West of I-95)
- Division 2 Entire Division
- Division 3 Entire Division
- Division 4 Edgecombe, Wayne, Johnston (East of US 301), Wilson (East of I-95), Nash (East of I-95), Halifax (East of I-95)
- Division 6 Bladen, Columbus, Robeson, Cumberland, Harnett (South of NC 27)
- Division 8 Scotland, Hoke, Moore (Southeast of US 15-501, NC 73, NC 211), Richmond (East of US 220 North and US 1 South)

Table 1018-2 shall be applicable to the flood plains of the Roanoke, Tar, Neuse, Cape Fear and Lumber Rivers and their tributaries that are outside the above described areas.

(2) Waste or by-products from industrial processes or mining operations are not acceptable except by specific written approval.

(3) When tested, soils having a pH of less than 5.5 or an organic content more than 4.0% may be rejected.

- 1 (4) When material is to be used for placing embankments or backfilling of undercut
2 areas that are excessively wet, the material shall consist of Class II, III or IV select
3 material.

4 **SECTION 1019**
5 **SHOULDER AND SLOPE MATERIAL**

6 **1019-1 GENERAL**

7 Use shoulder and slope material to construct shoulders and plate slopes with materials capable
8 of supporting vegetation. Material that contains roots, root mats, stumps or other
9 unsatisfactory material will not be acceptable.

10 **1019-2 SHOULDER AND SLOPE BORROW**

11 Use borrow sources in accordance with Article 1018-2.

12 Use soil consisting of loose, friable, sandy material with a PI greater than 6 and less than 25
13 and a pH ranging from 5.5 to 6.8. Remove stones and other foreign material 2" or larger in
14 diameter.

15 Use approved material obtained from unclassified excavation, fine grading operations or
16 borrow sources as provided in Section 230.

17 **1019-3 AGGREGATE SHOULDER BORROW**

18 Use aggregate shoulder borrow (ASB) that meets the following gradation in Table 1019-1.

TABLE 1019-1	
GRADATION OF AGGREGATE SHOULDER BORROW	
Sieve	Percentage Passing
1 1/2"	100
1/2"	55-95
#4	35-74

19 **SECTION 1020**
20 **ASPHALT MATERIALS**

21 **1020-1 DELIVERY AND ACCEPTANCE OF ASPHALT MATERIALS**

22 Asphalt materials are accepted at the source of shipment subject to the conditions herein.

23 All asphalt transport tankers, including rail and truck tankers, shall have a sampling valve in
24 accordance with Asphalt Institute Publication MS-18, ASTM D140 or a comparable device
25 acceptable to the Engineer.

26 Each transport tanker delivering asphalt materials to the project or rail siding shall keep
27 a running log showing the date, destination and type and grade of material hauled on each
28 trip. Print, stamp, or write in ink information appearing in the log and have available for
29 examination upon request.

30 Furnish with each shipment 2 copies of a delivery ticket. Ensure both copies accompany the
31 shipment and are delivered to the Engineer or his representative at the destination. The
32 delivery ticket shall contain the following information:

- 33 (A) Name of Producer/Supplier and location
34 (B) A statement that the material has been tested and meets AASHTO specifications or is
35 being provided by an approved supplier under Approved Supplier Certification (ASC)
36 (C) The grade of the material
37 (D) If applicable, the rotational viscosity in Pascal-Seconds (Pa-S) at 135°C and 165°C
38 (E) If applicable, the recommended laboratory mixing and compaction temperature (°C for
39 the PGAB)

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- 1 (F) Delivery ticket number
- 2 (G) Date and time loaded (mm/dd/yyyy AM:PM)
- 3 (H) Date and time shipped (mm/dd/yyyy AM:PM)
- 4 (I) State project or purchase order number
- 5 (J) NCDOT assigned batch number
- 6 (K) Destination
- 7 (L) Name of consignee
- 8 (M) Trailer or car number
- 9 (N) Producer's or Supplier's storage tank and batch number
- 10 (O) Quantity loaded in tons or gallons (kg/L) at 60°F
- 11 (P) Loading temperature
- 12 (Q) Net gallon at 60°F

13 When anti-strip additive is introduced into the asphalt binder, ensure the delivery ticket notes
14 the brand, grade and percentage or quantity at which the additive was introduced.

15 The Contractor's asphalt materials supplier shall furnish to the Materials and Tests Unit
16 a typical viscosity-temperature chart at the beginning of each calendar year and a new chart
17 whenever a change in production results in a shift of 5°F or more.

18 Furnish a statement of certification from the supplier and a separate statement of certification
19 from the transporter. Sign each certification by an authorized representative of the supplier or
20 transporter. Stamp, write or print these certifications on the delivery ticket, or attach to the
21 delivery ticket.

22 Unless otherwise approved by the Engineer, the following form shall be used in the supplier's
23 certification:

24 This is to certify that this shipment of _____ gallons/liters or
25 tons/metric tons of _____ grade asphalt including _____
26 gallons/liters of _____ anti-strip meet all requirements of
27 NC Department of Transportation Specifications.

28 Signed _____
29 Authorized Representative of Supplier

30 When no anti-strip additive is included with the load, the supplier shall indicate zero (0) in the
31 gallons field and "NA" in the anti-strip field on the above certification.

32 Unless otherwise approved by the Engineer, the following form shall be used in the
33 transporter's certification:

34 This is to certify that this transport tank was clean and free from
35 contaminating materials when loaded. The material transported on the
36 previous load in this tanker was _____.

37 Signed _____
38 Authorized Representative of Transporter

39 Failure to sign the certifications by either the supplier or transporter will be cause to withhold
40 use of the material until a sample can be taken and tested, except where an alternative testing
41 and invoicing procedure has been pre-approved by the Engineer.

42 The Engineer reserves the right to sample and test any shipment regardless of whether or not
43 the above conditions have been met and to reject any material not meeting the Specifications.

44 **1020-2 ASPHALT BINDER**

45 Use performance graded asphalt binder meeting AASHTO M 320 Table 1. See Article 610-3
46 for the specified grades.

1 Submit a Quality Control Plan for asphalt binder production in conformance with
 2 AASHTO R 26 to the Materials and Tests Unit. The Department's Performance Graded
 3 Asphalt Binder QC/QA Program shall be implemented in accordance with Article 1020-6.

4 Where modification of the asphalt binder is required to meet the specified grade, accomplish
 5 the modification using a styrene butadiene styrene (SBS), styrene butadiene rubber (SBR),
 6 styrene butadiene (SB) polymer or other modifiers approved by the Engineer to modify
 7 asphalt to meet the grade specified before delivery to the asphalt plant. Other polymers shall
 8 be pre-approved and listed by the Materials and Tests Unit. Air blown asphalt will not be
 9 permitted.

10 **1020-3 ASPHALT EMULSION**

11 Submit a QC Plan for asphalt emulsion. The Department's Asphalt Emulsion
 12 QC/QA Program shall be implemented in accordance with Article 1020-6.

13 **(A) Anionic**

14 Use asphalt emulsion, except for Grade RS-1H, that meets AASHTO M 140. Use asphalt
 15 emulsion Grade RS-1H that meets AASHTO M 140 for Grade RS-1, except the
 16 penetration of residue shall be at least 50 and no more than 100.

17 Perform the testing of the asphalt in accordance with AASHTO T 59 except as follows:

- 18 (1) Use a hot plate instead of an oven to perform the residue by evaporation.
- 19 (2) The determination of coating test, oil distillate, pH, solubility of residue, ash and
 20 particle charge will be made when deemed necessary.
- 21 (3) Use Materials and Tests Method A-24 to determine the coating ability and water
 22 resistance using either crushed or uncrushed aggregate from a source selected by the
 23 Department.

24 **(B) Cationic**

25 Asphalt emulsion shall meet AASHTO M 208 except as follows:

- 26 (1) Asphalt emulsion Grade CRS-1H shall meet AASHTO M 208 for Grade CRS-1
 27 except as follows:
 - 28 (a) The residue after distillation shall be at least 55%.
 - 29 (b) The penetration of residue shall be at least 50 and no more than 100.
 - 30 (c) Viscosity, Saybolt Furol at 77°F shall be at least 20 and no more than 100.
- 31 (2) All polymer or latex modified cationic asphalt emulsion materials, CRS-2P and
 32 CRS-2L, are subject to the following requirements:
 - 33 (a) The viscosity at 122°F shall be at least 100 seconds and no more than
 34 400 seconds.
 - 35 (b) The sieve shall be no more than 0.15%.
 - 36 (c) The 24 hour storage stability shall not exceed 1%.
 - 37 (d) The residue by evaporation (oven evaporation) shall be at least 65%.
 - 38 (e) The elastic recovery (AASHTO T 301) at 50°F shall be at least 50%.
 - 39 (f) The ring and ball softening point (AASHTO T 53) shall be at least 110°F.
 - 40 (g) Polymer content may be analyzed, if deemed necessary.

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(3) Perform the testing of the asphalt in accordance with AASHTO T 59 except as follows:

(a) Residue by evaporation will be performed using a hot plate instead of an oven with a maximum temperature of 400°F. Referee testing will be performed in accordance with AASHTO T 59.

(b) The determination of coating test, oil distillate, pH, solubility of residue, ash and particle charge will be made when deemed necessary by the Engineer.

(c) Materials and Tests Method A-24 is used to determine the coating ability and water resistance using either crushed or uncrushed aggregate from a source selected by the Department.

1020-4 POLYMER MODIFIED EMULSION MEMBRANE

Use polymer modified emulsion membrane consisting of styrene butadiene block copolymer modified asphalt emulsion to form a water impermeable seal and bond the new hot mix to the existing surface. Complete polymer modification of base asphalt before emulsification. Conform to Table 1020-1.

Property	Requirement		Test Method
	Min.	Max.	
EMULSION:			
Viscosity @ 77°F, SFS	20	100	AASHTO T 59
Sieve Test, %		0.1	AASHTO T 59
24-Hour Storage Stability, % ^A		1	AASHTO T 59
Residue from Distillation @ 400°F, % ^B	63		AASHTO T 59
Oil portion from distillation ml of oil per 100 g emulsion		2.0	
Demulsibility	60		AASHTO T 59
RESIDUE:			
Solubility in TCE, % ^C	97.5		AASHTO T 44
Elastic Recovery, 50°F			
20 cm elongation % ^D	60		AASHTO T 301
Penetration @ 77°F, 100 g, 5 sec, d _{mm}	60	150	AASHTO T 49

A. After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.

B. AASHTO T 59 with modifications to include a 400°F ± 10°F maximum temperature to be held for 15 minutes.

C. ASTM D5546 may be substituted where polymers block the filter in Method D 2042.

D. ASTM D6084 except that the elongation is 20 cm and the test temperature is 50°F.

1020-5 PRIME COAT MATERIALS

Supply prime coat materials from pre-approved sources in accordance with Materials and Tests Unit Method A and listed by the Materials and Tests Unit. Verification samples taken at the point of application (destination) are subject to the following conditions:

(A) All prime coat materials shall be delivered to the project ready for use.

(B) Sampling will be made at the point of application. The Department reserves the right to sample all materials used for prime coat applications, either at the destination or at the point of origin, and to withhold acceptance of material until analysis of such samples have been made. When a material meets specification requirements, but has a history of unsatisfactory service performance, its use for construction or maintenance purposes may be restricted by the Department and such restriction will be noted on the list of approved products.

- 1 (C) Proposed materials for prime coat applications that are not listed as approved will be
 2 investigated upon the request of the supplier or Contractor. The maximum volatile
 3 organic compounds for the products (materials) on the approved list for prime coat
 4 applications shall not exceed 6.8 oz/gal of material or the current applicable regulatory
 5 limit. Submit a MSDS and a 2 quart sample from 3 different batches of the same material
 6 to the Materials and Tests Unit for evaluation.
- 7 (D) The sand penetration results for a material used as a prime coat are penetration depth of at
 8 least 12 mm and penetration time of not more than 90 seconds. Copies of the *Sand*
 9 *Penetration Test Procedure* are available upon request from the Materials and Tests Unit.
- 10 (E) Materials used as a prime coat shall have a minimum rating of fair on the No-Tracking
 11 Time Test. Copies of the *No-Tracking Time Test Procedures* are available upon request
 12 from the Materials and Tests Unit.
- 13 (F) Materials used as a prime coat shall have a minimum rating of fair on the coating ability
 14 and water resistance test in accordance with AASHTO T 59.
- 15 (G) For materials stored longer than one day at the destination point (Contractors'/Divisions'
 16 tanks), submit to the Engineer a certified laboratory report on the performance of the
 17 material for storage stability test in accordance with AASHTO T 59.
- 18 (H) The diluted materials shall be tested for asphalt residue percent in accordance with
 19 AASHTO T 59, Section 55, and shall have a minimum asphalt residue percent of 15%.

20 **1020-6 PERFORMANCE GRADED ASPHALT BINDER AND ASPHALT**
 21 **EMULSION QUALITY CONTROL/QUALITY ASSURANCE**

22 The Performance Graded Asphalt Binder and Asphalt emulsion QC/QA Programs are
 23 designed to give asphalt binder and asphalt emulsion producers/suppliers (henceforth
 24 Producer designates Producer/Supplier) more responsibility for controlling the quality of
 25 material they produce and to use the quality control information they provide in the
 26 acceptance process by the Department. It requires asphalt binder and asphalt emulsion
 27 producers to perform quality control sampling, testing and record keeping on materials they
 28 ship for use by the Department. It documents that the Department will perform quality
 29 assurance sampling, testing and record keeping confirming the performance of the producers'
 30 control plan. In addition, the Producer is required to participate in independent assurance
 31 comparative sample activities. The program is described in the *Performance Graded Asphalt*
 32 *Binder and Asphalt Emulsion QC/QA Program Manuals*. An electronic copy of the program
 33 manuals may be obtained by accessing the Materials and Tests website.

34 The types of samples and the lot sizes required by the Producers and the Department are
 35 described in detail in the *Performance Graded Asphalt Binder and Asphalt Emulsion*
 36 *QC/QA Program Manuals*.

37 Acceptance or rejection of material will be based on the total program. Therefore,
 38 a comparison of the quality control, quality assurance and other sample data may be used by
 39 the Department for acceptance or rejection of a lot of material.

40 Participation in this program does not relieve the producer of the responsibility of complying
 41 with all requirements of the *Standard Specifications*.

42 **1020-7 WATERPROOFING AND DAMPPROOFING MATERIALS**

43 **(A) Asphalt Primer**

44 Asphalt primer shall meet **ASTM D41**.

45 **(B) Asphalt Binder**

46 Asphalt Binder shall meet Article 1020-2, Grade PG 64-22.

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(C) Tar

Tar shall meet ASTM D490.

(D) Fabric

Woven cotton fabric for waterproofing shall meet ASTM D173.

**SECTION 1024
MATERIALS FOR PORTLAND CEMENT CONCRETE**

1024-1 PORTLAND CEMENT

Supply Portland cement that meets AASHTO M 85 for Type I, II or III except that the maximum fineness requirements of AASHTO M 85 do not apply to cement used in precast concrete products. Throughout these Specifications Types I and II cement are referred to as regular Portland cement and Type III as high early strength Portland cement.

Certain combinations of cement and aggregate exhibit an adverse alkali-silica reaction. The alkalinity of any cement, expressed as sodium-oxide equivalent, shall not exceed 1.0%. For mix designs that contain non-reactive aggregates and cement with an alkali content less than 0.6%, straight cement or a combination of cement and fly ash, cement and ground granulated blast furnace slag or cement and microsilica may be used. The pozzolan quantity shall not exceed the amount shown in Table 1024-1. For mixes that contain cement with an alkali content between 0.6% and 1.0% and for mixes that contain a reactive aggregate documented by the Department, use a pozzolan in the amount shown in Table 1024-1.

Obtain the list of reactive aggregates documented by the Department at the Materials and Tests Unit website.

TABLE 1024-1 POZZOLANS FOR USE IN PORTLAND CEMENT CONCRETE	
Pozzolan	Rate
Class F Fly Ash	20% by weight of required cement content with 1.2 lb Class F fly ash per lb of cement replaced
Ground Granulated Blast Furnace Slag	35%-50% by weight of required cement content with 1.0 lb slag per lb of cement replaced
Microsilica	4%-8% by weight of required cement content with 1.0 lb microsilica per lb of cement replaced

Type IP or IS blended cement is allowed for the cement-and-fly-ash or cement-and-slag portion of the mix. Type IT may be allowed for the cement-and-pozzolan portion of the mix with the permission of the Engineer. Do not substitute fly ash or slag for a portion of Type IP, IS or IT cement or for Portland cement in high early strength concrete.

Use white cement that meets ASTM C150, except that the ferric oxide content is limited to 0.5%.

Use Type IP blended cement that meets AASHTO M 240, except that the pozzolanic content is limited to between 17 and 23% by weight and the constituents shall be interground.

Use Type IS blended cement that meets AASHTO M 240 except that the slag content is limited to between 35% and 50% by weight and the constituents are interground.

Use Type IT blended cement that meets AASHTO M 240. The Engineer will evaluate the blend of constituents for acceptance in Department work.

Do not use air-entraining Portland cement. Do not mix different types of cement, different brands of cement, or the same brand from different mills nor use them alternately except when authorized in writing by the Engineer.

1 Protect cement from contamination or damage during handling and storage. Do not use
2 cement that is damaged, partially set, lumpy or caked.

3 All cement is sampled and tested by the Department as it arrives on the project or at the
4 precasting plant at such frequency as established by the Department.

5 **1024-2 AGGREGATE**

6 Provide aggregate that meets Section 1014.

7 **1024-3 ADMIXTURES**

8 **(A) Basis of Acceptance**

9 Admixtures from an approved source are accepted without prior testing. Do not use
10 admixtures that are not from an approved source until the admixture is approved by the
11 Department.

12 **(B) Approved Sources**

13 An approved source is considered to be any manufacturer of admixtures who complies
14 with this subarticle.

15 The manufacturer shall submit to the Materials and Tests Unit certified reports of tests
16 that show that the admixture meets the applicable Specifications. Perform tests in
17 a laboratory certified by the Cement and Concrete Reference Laboratory of the National
18 Bureau of Standards.

19 Admixtures that contain chloride other than calcium chloride as provided herein are not
20 permitted. The manufacturer is required to state in writing that no chloride was added
21 during the manufacture of the admixture.

22 After an admixture is accepted, the manufacturer is required to submit to the Materials
23 and Tests Unit on or before February 1 of each year a notarized certification that shows
24 that the material is of the same composition as originally accepted and has not been
25 changed or altered. If an admixture is changed or altered, approval of the source in
26 accordance with the above requirements is necessary before using the admixture.

27 The Engineer has the option to make any or all tests deemed desirable to verify the
28 manufacturer's certification. Failure of the admixture in such tests is cause for
29 discontinuation of its use. Failure of an admixture to perform satisfactorily under job
30 conditions is cause for rejection of the source.

31 The Engineer maintains a list of approved sources on file.

32 **(C) Air Entraining Agent**

33 Provide air entraining agents that meet AASHTO M 154.

34 **(D) Chemical Admixtures**

35 **(1) Set Retarding Admixtures**

36 Use set retarding admixtures that meet AASHTO M 194 for Type D, water reducing
37 and retarding admixtures.

38 **(2) Water Reducing Admixtures**

39 Use water reducing admixtures that meet AASHTO M 194 for Type A admixtures.

40 **(3) Calcium Chloride**

41 Provide calcium chloride that meets AASHTO M 144 for Type 2, concentrated flake,
42 pellet or other granular calcium chloride. The Engineer may waive the gradation
43 requirement.

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1 (4) High-Range Water Reducing Admixtures

2 Use high-range water reducing admixtures that meet AASHTO M 194 for Type F or
3 Type G.

4 (5) Calcium Nitrite Corrosion Inhibitor

5 Use an approved calcium nitrite corrosion inhibitor that contains 30% solids.

6 (E) Other Admixtures

7 Admixtures not otherwise classified will be reviewed on a case-by-case basis by the
8 Materials and Tests Unit.

9 1024-4 WATER

10 Ensure that water used to condition, wash, or as an integral part of materials is clear and free
11 from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substance. It
12 shall not be salty or brackish. Water used in the production of concrete or grout shall be from
13 wells or public water systems which are suitable for drinking and must meet the criteria listed
14 in Table 1024-2.

15 Test all water from wells and public water supplies from all out of state locations and in the
16 following counties: Beaufort, Bertie, Brunswick, Camden, Carteret, Chowan, Craven,
17 Currituck, Dare, Gates, Hyde, New Hanover, Onslow, Pamlico, Pasquotank, Pender,
18 Perquimans, Tyrell and Washington unless the Engineer waives the testing requirements.
19 Water from a municipal water supply in all other NC counties may be accepted by the
20 Engineer without testing.

**TABLE 1024-2
PHYSICAL PROPERTIES OF WATER**

Property	Requirement	Test Method
Compressive Strength, minimum percent of control at 3 and 7 days	90%	NCDOT Modified / AASHTO T 106
Time of set, deviation from control	From 1:00 hr. earlier to 1:30 hr. later	NCDOT Modified / AASHTO T 131
pH	4.5 to 8.5	NCDOT Modified / AASHTO T 26
Chloride Ion Content, Max.	250 ppm	ASTM D512
Total Solids Content (Residue), Max.	1,000 ppm	NCDOT Modified / Standard Methods for Examination of Water and Wastewater
Resistivity, Min.	0.500 kohm-cm	NCDOT Modified / ASTM D1125
Sulfate as SO ₄ , Max.	1,500 ppm	NCDOT Modified / ASTM D516
Presence of Sugar	None	NCDOT Procedure
Dissolved Organic Matter	None	NCDOT Modified / AASHTO T 26

21 1024-5 FLY ASH

22 Provide fly ash that meets ASTM C618 for Class F or Class C, except ensure that the loss on
23 ignition does not exceed 4%. Table 1A of ASTM C618 applies to Class F fly ash. Use fly
24 ash that meets the optional physical requirements for uniformity shown in Table 2A of
25 ASTM C618.

26 Do not use Class C fly ash in Portland cement concrete if the alkali content of the cement
27 exceeds 0.4%.

1 All fly ash is sampled and tested by the Department as it arrives on the project at such
2 frequency as established by the Department.

3 **1024-6 GROUND GRANULATED BLAST FURNACE SLAG**

4 Use blast furnace slag that meets AASHTO M 302, Grade 100. All slag is sampled and tested
5 by the Department as it arrives on the project at such frequency as established by the
6 Department.

7 **1024-7 SILICA FUME**

8 Provide silica fume (microsilica) that meets Tables 1, 2 and 3 of ASTM C1240. All silica
9 fume is sampled and tested by the Department as it arrives on the project at such frequency as
10 established by the Department.

11 **SECTION 1026** 12 **CURING AGENTS FOR CONCRETE**

13 **1026-1 GENERAL**

14 All curing agents shall be free from impurities that may be detrimental to the concrete. Do
15 not use curing agent until the applicable tests have been performed and the Engineer has
16 approved the curing agent.

17 **1026-2 LIQUID MEMBRANE CURING COMPOUNDS**

18 **(A) General**

19 Liquid membrane curing compounds shall meet AASHTO M 148, except that when
20 tested in the water retention test described in AASHTO T 155 the curing compound shall
21 restrict the loss of water in the test specimen at the time of application of the compound
22 to not more than 0.007 oz./sq.in.

23 The curing compound shall be Type 2, white pigmented, except where clear type is
24 required for a particular application, the curing compound shall be Type 1D, clear or
25 translucent with fugitive dye.

26 Deliver curing compound in the manufacturer's original clean, sealed containers.
27 Legibly mark each container with the name of the manufacturer, the name of the
28 compound, the type of compound, the manufacturer's batch number, the date of
29 manufacture and the manufacturer's recommended shelf life.

30 Do not use curing compound that has been in storage for more than one year from the
31 date of manufacture or more than the manufacturer's recommended shelf life, whichever
32 is less.

33 **(B) Test Procedures**

34 Curing compound will be tested in accordance with AASHTO M 148, except the size of
35 molds for making test specimens will be approximately 5.5" in diameter by
36 approximately 1" deep, or any other size selected by the Engineer.

37 **1026-3 POLYETHYLENE FILM**

38 Polyethylene film shall meet AASHTO M 171 for white opaque polyethylene film, except
39 that when tested for moisture retention efficiency the loss shall not be more than
40 0.007 oz./sq.in of surface area.

41 **1026-4 WATER**

42 All water used for curing concrete shall meet Article 1024-4 and Table 1024-2. Water from
43 wells, streams, ponds or public water systems may be used.

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1 **1026-5 BURLAP**

2 Burlap shall meet AASHTO M 182. Any class of burlap will be acceptable.
3 Use new burlap or burlap that has been used for no purpose other than curing concrete. New
4 burlap shall be free from starch, filler or other substances added during manufacture, or shall
5 be washed to remove such substances before use.

6 **SECTION 1028**
7 **JOINT MATERIALS**

8 **1028-1 JOINT FILLER**

9 Provide a nonbituminous type joint filler that meets AASHTO M 153 for Types I, II or III, or
10 a bituminous type that meets AASHTO M 213. Furnish a Type 3 material certification in
11 accordance with Article 106-3 with each lot of the joint material supplied to each project.

12 **1028-2 HOT APPLIED JOINT SEALER**

13 Provide a hot applied joint sealer that conforms to ASTM D6690 and has been evaluated by
14 NTPEP. Furnish a Type 3 material certification in accordance with Article 106-3 for each lot
15 of the joint sealer supplied to each project.

16 **1028-3 LOW MODULUS SILICONE SEALANT**

17 Provide a cold applied, single component, chemically curing low modulus silicone sealant
18 from the Department’s approved list on the website and evaluated by NTPEP. Acid cure
19 sealants are not acceptable for use on Portland cement concrete. Bond breakers shall meet
20 Article 1028-4.

21 **(A) Silicone Sealant Types**

22 (1) Type NS

23 A non-sag silicone for use in sealing horizontal and vertical joints in Portland cement
24 concrete pavements and bridges. Tooling is required.

25 (2) Type SL

26 A self-leveling silicone used to seal horizontal joints in Portland cement concrete
27 pavements and bridges. Tooling is not normally required.

28 **(B) Requirements**

TABLE 1028-1 PHYSICAL PROPERTIES OF SEALANT		
Property	Requirement	Test Method
Peel	Minimum of 20 lb/in of width with at least 75% cohesive failure	ASTM D903 bonded on concrete block
Movement Capability and Adhesion	No adhesive or cohesive failure after 10 cycles of test movements of +100% (extension) and -50% (compression)	ASTM C719

29 Silicone sealant shall meet the Table 1028-1, ASTM D5893 and shall have been
30 evaluated by NTPEP.

31 Furnish a Type 3 material certification in accordance with Article 106-3 for each lot of
32 joint sealer material supplied to each project. Deliver each lot of sealant in containers
33 plainly marked with the manufacturer’s name or trademark, lot number and date of
34 manufacture.

1 **1028-4 BOND BREAKER**

2 Install silicone sealant over a bond breaker to prevent the sealant from bonding to the bottom
3 of the joint. Use bond breakers that do not stain or adhere to the sealant and are chemically
4 inert and resistant to oils. Furnish a Type 3 material certification in accordance with
5 Article 106-3 for each lot of bond breaker material supplied to each project.

6 **(A) Type L**

7 Type L backer rod is a closed-cell expanded polyethylene foam backer rod. Use this
8 backer rod in roadway and bridge joints and with Type NS silicone only. Use
9 Type L backer rod that complies with Table 1028-2.

10 **(B) Type M**

11 Type M backer rod is a closed-cell polyolefin foam backer rod which has a closed-cell
12 skin over an open cell core. Use this backer rod in roadway and bridge joints with both
13 silicone sealant types. Use Type M backer rod that complies with Table 1028-2.

TABLE 1028-2		
PHYSICAL PROPERTIES OF TYPE L AND TYPE M BACKER ROD		
Property	Requirement	Test Method
Min. Density	2.0 lb/cf	ASTM D1622
Min. Tensile Strength	25 psi	ASTM D1623
Max. Water Absorbtion	0.5% by volume	ASTM C509

14 **(C) Type N**

15 Provide bond breaking tape made from extruded polyethylene that has a pressure
16 sensitive adhesive on one side. Bond breaking tape may be used with both types of
17 silicone but is suitable for bridge joints only. Bond breaking tapes shall be at least
18 0.005" in thickness.

19 **SECTION 1032**
20 **CULVERT PIPE**

21 **1032-1 CORRUGATED METAL CULVERT PIPE**

22 Use corrugated metal culvert pipe from sources on the Department's approved list and that
23 participate in the Department's Brand Registration program for metal culvert pipe available
24 from the website or the Materials and Tests Unit's Central Laboratory. The Department will
25 remove a manufacturer of metal culvert pipe from this program if the monitoring efforts
26 indicated that non-specification material is being provided or test procedures are not being
27 followed.

28 The following types of steel and aluminum alloy pipe and all associated accessories may be
29 accepted under this program.

30 **(A)** Coated corrugated metal culvert pipe and pipe arches,

31 **(B)** Coated corrugated metal end sections, coupling band and other accessories,

32 **(C)** Corrugated aluminum alloy structural plate pipe and pipe arches,

33 **(D)** Corrugated aluminum alloy end sections, coupling band and other accessories, and

34 **(E)** Welded steel pipe.

35 **1032-2 CORRUGATED ALUMINUM ALLOY CULVERT PIPE**36 **(A) Corrugated Aluminum Alloy Culvert Pipe**

37 Corrugated aluminum alloy culvert pipe shall meet AASHTO M 196, except that
38 Type IA pipe will not be permitted.

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1 When elongated pipe is called for by the contract, use pipe that is shop formed to provide
2 for a 5% vertical elongation.

3 Coupling bands with projections may be used for circumferential pipe, helical pipe, or
4 a combination of both.

5 **(B) Corrugated Aluminum Alloy Pipe Tees and Elbows**

6 Corrugated aluminum alloy pipe tees and elbows shall meet all applicable requirements
7 of AASHTO M 196.

8 **(C) Acceptance**

9 Acceptance of corrugated aluminum alloy culvert pipe and its accessories will be based
10 on, but not limited to, visual inspections, classification requirements and check samples
11 taken from material delivered to the project and conformance to the annual Brand
12 Registration.

13 Culvert pipe materials not meeting the above requirements will be rejected, unless written
14 approval is obtained from the State Materials Engineer.

15 **1032-3 CORRUGATED STEEL CULVERT PIPE**

16 **(A) Corrugated Steel Culvert Pipe and Pipe Arch**

17 Corrugated steel culvert pipe and pipe arch shall meet AASHTO M 36 with the following
18 exceptions:

19 (1) Coupling Bands

20 (a) Use corrugated coupling bands except as otherwise provided below.

21 (b) A hugger type corrugated band having one annular corrugation at each outside
22 edge of the band will be acceptable.

23 (c) Coupling bands with projections may be used where it is necessary to join new
24 pipe to existing pipe having helical corrugations at the joint locations. Use
25 an approved sealer with this type of coupling band.

26 (d) Fasten coupling bands on the ends with at least two 1/2" bolts.

27 (e) Annular corrugated bands shall have a minimum width of 10 1/2" where
28 2 2/3" x 1/2" corrugations are used.

29 (2) Corrugations

30 Where 1/4" deep corrugations are permitted by AASHTO M 36, the maximum pitch
31 of the corrugations shall be 1 7/8".

32 Where 3" x 1" corrugations are required, the Contractor will be permitted to use
33 5" x 1" corrugations.

34 Pipe with helical corrugations shall have rerolled ends with at least 2 annual
35 corrugations at each end.

36 (3) Elongated Pipe

37 When elongated pipe is called for by the contract, use pipe that is shop formed to
38 provide for a 5% vertical elongation.

1 (4) Lifting Straps

2 The pipe may be furnished either with or without lifting straps for handling. Attach
 3 the lifting straps by bolting or by welding. Bolt holes for attaching the straps shall be
 4 a smooth hole that is either punched or drilled. No burning of holes will be
 5 permitted. Design the lifting straps so the holes can be plugged to prevent
 6 infiltration of backfill material.

7 Design the placement of lifting straps to ensure the pipe is equally supported along
 8 its axis.

9 (5) Coating Repair

10 Repair shall be in accordance with Section 1076-7.

11 (6) Type IA Pipe

12 Type IA pipe will not be permitted.

13 (7) Aluminized Pipe

14 Aluminized pipe shall meet all requirements herein except that the pipe and coupling
 15 bands shall be fabricated from aluminum coated steel sheet meeting
 16 AASHTO M 274.

17 (8) Marking Requirements

18 Pipe sections and special attachments for pipe 60" or larger diameter pipe shall be
 19 alphanumerically match-marked at the plant site before shipping. There may be
 20 additional markings as required by the Department's Brand Certification Program.

21 **(B) Prefabricated Corrugated Steel Pipe End Sections**

22 Corrugated steel end sections shall be in accordance with the details shown in the plans
 23 and Subarticle 1032-3(A). Repair end sections on which the spelter coating has been
 24 bruised or broken either in the shop or in shipping in accordance with AASHTO M 36.

25 **(C) Corrugated Steel Pipe Tees and Elbows**

26 Corrugated steel tees and elbows shall be in accordance with Subarticle 1032-3(A).

27 **(D) Corrugated Steel Eccentric Reducers**

28 Corrugated steel eccentric reducers shall be in accordance with Subarticle 1032-3(A) and
 29 the additional requirements shown below.

30 Construct the eccentric reducer so the invert or flow line from the large pipe through the
 31 reducer and into the small pipe is a continuous straight line.

32 Make the reducer from the same thickness corrugated metals as the large diameter pipe.
 33 The reducing section may be riveted or welded.

34 **(E) Acceptance**

35 Acceptance of corrugated steel culvert pipe and its accessories will be based on, but not
 36 limited to, visual inspections, classification requirements and check samples taken from
 37 material delivered to the project and conformance to the annual Brand Registration.

38 Culvert pipe materials not meeting the above requirements will be rejected, unless written
 39 approval is obtained from the State Materials Engineer.

40 The reducing section shall reduce in diameter no more than 3" in 24" of length. Rivet or
 41 weld a 24" long constant diameter stub to each end of the reducing section to form the
 42 complete reducer.

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1 Have the completed reducer show careful, finished workmanship in all particulars.
2 Repair reducers on which the spelter coating has been bruised or broken either in the
3 shop or in shipping in accordance with AASHTO M 36. Reducers that show defective
4 workmanship will be rejected. The following defects are evidence of poor workmanship,
5 and the presence of any of them in any individual reducer will constitute sufficient cause
6 for rejection:

- 7 (1) Not meeting required dimensions,
- 8 (2) Not of the specified shape,
- 9 (3) Uneven laps,
- 10 (4) Ragged or diagonal sheared edges,
- 11 (5) Loose, unevenly lined or spaced rivets,
- 12 (6) Poorly formed rivet heads,
- 13 (7) Lack of rigidity,
- 14 (8) Dents or bends in the metal itself,
- 15 (9) Uneven welds, or
- 16 (10) Gaps in welds.

17 **1032-4 COATED, PAVED AND LINED CORRUGATED STEEL CULVERT PIPE**

18 **(A) Coatings for Steel Culvert Pipe or Pipe Arch**

19 The below coating requirements apply for steel culvert pipe, pipe arch, end sections, tees,
20 elbows and eccentric reducers.

- 21 (1) Steel Culvert pipe shall have an aluminized coating, meeting the requirement of
22 AASHTO M 274.
- 23 (2) When shown in the plans or as approved by the Engineer, a polymeric coating
24 meeting AASHTO M 246 for Type B coating may be substituted for aluminized
25 coating.

26 **(B) Acceptance**

27 Acceptance of coated steel culvert pipe and its accessories will be based on, but not
28 limited to, visual inspections, classification requirements and check samples taken from
29 material delivered to the project and conformance to the annual Brand Registration.

30 **1032-5 WELDED STEEL PIPE FOR DRAINAGE**

31 Welded steel pipe shall meet [ASTM A139](#) for the grade of pipe called for in the plans.

32 Acceptance of welded steel culvert pipe and its accessories will be based on, but not limited
33 to, visual inspections, classification requirements and check samples taken from material
34 delivered to the project and conformance to the Department's welded steel pipe program.

35 Culvert pipe materials not meeting the above requirements will be rejected, unless written
36 approval is obtained from the State Materials Engineer.

37 **1032-6 CONCRETE CULVERT PIPE**

38 **(A) General**

39 Use concrete pipe from sources participating in the Department's Concrete Pipe QC/QA
40 Program. A list of participating sources is available from the Materials and Tests Unit's
41 Central Laboratory. The Department will remove a manufacturer of concrete pipe from
42 this program if the monitoring efforts indicated that non-specification material is being
43 provided or testing procedures are not being followed.

(B) Reinforced Concrete Culvert Pipe

Reinforced concrete culvert pipe shall meet AASHTO M 170 for the class of pipe called for in the plans except as follows:

- (1) The permissible wall thickness outside of the joint configuration shall not be more than that shown in the design by more than 5% or 3/16", whichever is greater.
- (2) The maximum weighted average loss for both fine and coarse aggregates shall be 15% when subjected to 5 cycles of the soundness test.
- (3) The maximum percentage of wear for coarse aggregates is 55%.

The design wall thickness shall be either the wall thickness shown in AASHTO M 170 for the applicable class and wall or the wall thickness shown in a modified design that has been approved by the Engineer. A wall thickness greater than permitted by the above tolerance will be cause for rejection of the pipe. The circumferential steel in single cage pipe shall not be more than 3" from either end of the pipe section excluding the tongue and groove. On double cage pipe, extend one cage into the tongue or groove. Place the other cage so a circumferential wire shall be not less than 2" from the other end of the barrel of the pipe.

(C) Precast Concrete Pipe End Sections

Precast concrete pipe end sections shall meet AASHTO M 170 and Section 1077 except those requirements pertaining to design.

Design concrete pipe end sections in accordance with the plans or with plans prepared by the manufacturer which have been approved by the Engineer. Reinforce all concrete pipe end sections. Use air entrained concrete in pipe end sections with a strength of 3,500 psi when tested in accordance with AASHTO T 22.

(D) Concrete Pipe Tees and Elbows

Concrete pipe tees and elbows shall meet AASHTO M 170 for the class of pipe tee or elbow called for in the plans.

(E) Marking

- (1) Clearly etchmark the following information on the outside of each section of pipe, pipe end section, tee and elbow:
 - (a) Pipe class and type of wall if reinforced,
 - (b) The date of manufacture, and
 - (c) Name or trademark of the manufacturer.
- (2) Clearly stamp, stencil, sticker or paint the following information on each section of pipe, pipe end section, tee and elbow:
 - (a) The State assigned plant number,
 - (b) The inside diameter of the pipe product, and
 - (c) The year of manufacture. This marking shall be in the following format: State plant number - diameter - year (CP99-24-06).

When concrete pipe, pipe end sections, tees and elbows have been inspected and accepted they will be stamped with the Department seal of approval. Do not use pipe sections, pipe end sections, tees, or elbows which do not have this seal of approval. Failure of as much as 20% of any lot of pipe due to cracks, fractures, variation in alignment or other manufacturing defects will be cause for the rejection of the entire lot. The lots shall be as designated by the manufacturer before inspection.

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1 Individual lengths of pipe within the lot which were not specifically rejected but which
2 are considered acceptable by the manufacturer may be removed from the rejected lot and
3 resubmitted for inspection as a separate lot.

4 (F) Joint Materials

5 Cement shall meet Article 1024-1. Sand shall meet Article 1014-1 for fine aggregate or
6 Article 1040-7 for mortar sand. Hydrated lime shall meet Article 1040-6.

7 Flexible plastic joint material shall meet AASHTO M 198 for Type B flexible plastic
8 gaskets, except as follows:

- 9 (1) The flash point, Cleveland Open Cup (C.O.C.) shall be at least 325°F.
- 10 (2) The fire point, C.O.C. shall be at least 350°F.

11 1032-7 CORRUGATED POLYETHYLENE (HDPE) CULVERT PIPE

12 (A) General

13 Use corrugated polyethylene pipe from sources participating in the Department's HDPE
14 Pipe QC/QA Program. A list of participating sources is available from the Materials and
15 Tests Unit. The Department will remove a manufacturer of polyethylene pipe from this
16 program if the monitoring efforts indicated that non-specification material is being
17 provided or test procedures are not being followed.

18 Use corrugated polyethylene culvert pipe that meets AASHTO M 294 for Type S or
19 Type D and has been evaluated by NTPEP.

20 (B) End Treatments, Pipe Tees and Elbows

21 End treatments, pipe tees and elbows shall meet AASHTO M 294, Section 7.8.

22 (C) Marking

23 Clearly mark each section of pipe, end section, tee and elbow and other accessories
24 according to the Department's HDPE Pipe QC/QA Program:

- 25 (1) AASHTO Designation
- 26 (2) The date of manufacture
- 27 (3) Name or trademark of the manufacturer

28 When polyethylene pipe, end sections, tees and elbows have been inspected and accepted
29 they will be stamped with the Department seal of approval. Do not use pipe sections,
30 flared end sections, tees or elbows which do not have this seal of approval.

31 1032-8 PVC PROFILE WALL DRAIN PIPE

32 PVC pipe shall conform to AASHTO M 304. When rubber gaskets are to be installed in the
33 pipe joint, the gasket shall be the sole element relied on to maintain a tight joint. Watertight
34 joints shall be watertight in accordance with AASHTO M 304, unless a higher pressure rating
35 is specified in the plans.

36 SECTION 1034

37 SANITARY SEWER PIPE AND FITTINGS

38 1034-1 CLAY PIPE

39 Use extra strength vitrified clay sewer pipe conforming to ASTM C700. Manufacture all
40 joints and seals in accordance with ASTM C425.

1 **1034-2 PLASTIC PIPE**

2 **(A) PVC Gravity Flow Sewer Pipe**

3 Use PVC pipe that conforms to ASTM D3034 with a minimum SDR of 35. Use pipe
4 with push-on type joints having bells made as an integral part of the pipe conforming to
5 ASTM D3212.

6 **(B) PVC Force Main Sewer Pipe**

7 (1) Pressure Rated Pipe

8 Use PVC pipe conforming to ASTM D2241 or to ANSI/AWWA C905 with
9 a minimum SDR of 21 and minimum pressure rating of 200 psi. Use pipe with
10 push-on type joints having bells made as an integral part of the pipe conforming to
11 ASTM D3139 or pipe with butt fused joints made from ASTM D1784
12 Class 12454B plastic formulated for fusing.

13 Use PVC pipe conforming to ASTM F1483 or to ANSI/AWWA C909 for
14 molecularly oriented pipe with a minimum pressure rating of 200 psi. Use pipe with
15 push-on type joints having bells made as an integral part of the pipe conforming to
16 ASTM D3139.

17 (2) Pressure Class Pipe

18 Use PVC pipe conforming to ANSI/AWWA C900 with a minimum DR of 18 and
19 a minimum pressure class of 235 psi. Use pipe with push-on type joints having bells
20 made as an integral part of the pipe conforming to ASTM D3139 or pipe with butt
21 fused joints made from ASTM D1784 Class 12454B plastic formulated for fusing.

22 **(C) Polyethylene (PE) Pipe Force Main Sewer Pipe**

23 Use PE pipe and tubing that conforms to AWWA C901 or AWWA C906 with
24 a minimum pressure class of 200 psi.

25 **1034-3 CONCRETE SEWER PIPE**

26 Use reinforced concrete sewer pipe conforming to ASTM C76 or AASHTO M 170 with
27 a Class III minimum rating. Use pipe with gasket joints conforming to ASTM C443 or
28 AASHTO M 198 Type A or B.

29 **1034-4 DUCTILE IRON PIPE**

30 **(A) Gravity Flow Sewer Pipe**

31 Use ductile iron pipe that conforms to ASTM A746 or ANSI/AWWA C151/A21.51.

32 Use ductile iron pipe fittings and specials conforming to ANSI/AWWA C110/A21.10 for
33 standard size fittings or ANSI/AWWA C153/A21.53 for compact fittings.

34 Use pipe and fittings with push-on joints conforming to ANSI/AWWA C111/A21.11.

35 **(B) Force Main Sewer Pipe**

36 Use ductile iron pipe that conforms to ANSI/AWWA C151/A21.51.

37 Use ductile iron pipe fittings and specials conforming to ANSI/AWWA C110/A21.10 for
38 standard size fittings or ANSI/AWWA C153/A21.53 for compact fittings. Manufacture
39 fittings with a cement mortar lining and a seal coat in accordance with
40 ANSI/AWWA C104/A21.4.

41 Use pipe and fittings with either mechanical joints or push-on joints conforming to
42 ANSI/AWWA C111/A21.11. When required or necessary, use approved type joint
43 restraint devices with a minimum working pressure rating of 200 psi and a factor of
44 safety of 2.

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**SECTION 1036
WATER PIPE AND FITTINGS**

1036-1 GENERAL

All materials when used to convey potable drinking water shall meet the National Sanitation Foundation Standard No. 61.

1036-2 COPPER PIPE

For indoor plumbing use copper pipe and sweated fittings conforming to ASTM B88 for the type and temper called for in the plans and Specifications. Cast fittings for copper pipe shall meet ASTM B61 or ASTM B62.

For buried service, use copper water pipe and tube conforming to ASTM B88 soft annealed Type K. Use flared or compression type fittings conforming to ANSI/AWWA C800 and local plumbing codes to connect pipe and tube.

1036-3 PLASTIC PIPE

(A) PVC Pipe

(1) Pressure Rated Pipe

Use PVC pipe conforming to ASTM D2241 or to ANSI/AWWA C905 with a minimum SDR of 21 and minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139 or pipe with butt fused joints made from ASTM D1784 Class 12454B plastic formulated for fusing.

Use PVCO pipe conforming to ASTM F1483 or to ANSI/AWWA C909 for molecularly oriented pipe with a minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139.

(2) Pressure Class Pipe

Use PVC pipe conforming to ANSI/AWWA C900 with a minimum DR of 18 and a minimum pressure class of 235 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139 or pipe with butt-fused joints made from ASTM D1784 Class 12454B plastic formulated for fusing.

(B) Polyethylene (PE) Pipe

Use PE water pipe and tubing that conforms to AWWA C901 or AWWA C906 with a minimum pressure class of 200 psi.

1036-4 STEEL PIPE

(A) Water Pipe

Use galvanized steel pipe meeting ASTM A53 for standard weight. Fittings for steel water pipe shall meet ASTM A126 for Class B iron or of ASTM A197. Galvanize all fittings in accordance with ASTM A153.

(B) Encasement Pipe

Use steel pipe meeting an ASTM specification with the minimum yield strength of 35,000 psi. Use pipe that is circular in shape and straight in length.

1036-5 DUCTILE IRON PIPE AND FITTINGS

Use ductile iron pipe that conforms to ANSI/AWWA C151/A21.51.

1 Use ductile iron pipe fittings and specials conforming to ANSI/AWWA C110/A21.10 for
2 standard size fittings or ANSI/AWWA C153/A21.53 for compact fittings. Manufacture
3 fittings with a cement mortar lining and a seal coat in accordance with
4 ANSI/AWWA C104/A21.4.

5 Use either mechanical joints or push-on joints conforming to ANSI/AWWA C111/A21.11.
6 When required or necessary, use approved type joint restraint devices with a minimum
7 working pressure rating of 200 psi and a factor of safety of 2.

8 **1036-6 FIRE HYDRANTS**

9 Use dry barrel type fire hydrants conforming to ANSI/AWWA C502 with a minimum
10 4 1/2" diameter valve opening with a 6" mechanical joint inlet connection, with two
11 2 1/2" hose connections and with one 4 1/2" pumper connection. Outlets shall have national
12 standard fire hose coupling threads. Use fire hydrants with a minimum bury length of 36".
13 Securely chain nipple caps to the barrel. Paint hydrants with one coat of primer paint and
14 2 coats of an approved paint of the owner's standard color. Apply the final coat after hydrant
15 installation.

16 **1036-7 WATER VALVES**

17 **(A) Gate Valves**

18 Use iron body gate valves which conform to ANSI/AWWA C500 for bronze mounted,
19 double disc, parallel seat type valves or to ANSI/AWWA C509 for resilient seat-type
20 valves or to ANSI/AWWA C515 for reduced-wall, resilient seat gate valves. For buried
21 service use gate valves with non-rising stems, 2" square operating nuts, O-ring seals and
22 which open by turning counter clockwise. Gate valves shall have mechanical joint ends
23 conforming to ANSI/AWWA C111/A21.11. Gate valves shall have a design working
24 water pressure of 200 psi.

25 **(B) Bronze Gate Valves**

26 Use bronze gate valves conforming to ASTM B62 with tee head operating nuts and solid
27 wedges. Use valves with a design working pressure of 200 psi.

28 **(C) Tapping Valves**

29 Use tapping valves conforming to Subarticle 1036-7(A) with appropriately sized
30 openings, with flanged by mechanical joint ends and pressure rated at 200 psi.

31 **1036-8 SLEEVES, COUPLINGS AND MISCELLANEOUS**

32 **(A) Tapping Sleeves**

33 Use cast iron, ductile iron or Type 304 stainless steel tapping sleeves pressure rated
34 at 200 psi. Use either the split sleeve type with mechanical joint ends or the full circle
35 type with double seals. Manufacture the outlet flange to mate with the tapping valve
36 flange.

37 **(B) Transition Sleeves and Couplings**

38 Use sleeve type couplings for transitioning between plain ends of different pipe types.
39 Manufacture couplings in conformance with ANSI/AWWA C219 for a rated working
40 pressure of 200 psi. Coat the coupling at the factory with an epoxy in conformance with
41 ANSI/AWWA C210 or ANSI/AWWA C213.

42 **1036-9 SERVICE LINE VALVES AND FITTINGS**

43 Use corporation stops and curb stops of all bronze material and high-pressure construction
44 conforming to ANSI/AWWA C800.

Section 1040

1 Use tapping saddles of high-pressure construction, shaped to conform to the pipe and in
2 conformance with ANSI/AWWA C800.

3 Use high-pressure fittings manufactured in conformance with ANSI/AWWA C800.

SECTION 1040

MASONRY

1040-1 BRICK

7 Use clay or shale brick that meets ASTM C62 for Grade SW, except as otherwise provided
8 herein.

9 Use brick of uniform standard commercial size, with straight and parallel edges and square
10 corners that are burned hard and entirely true, free from injurious cracks and flaws, tough,
11 strong and have a clear ring when struck together. The sides, ends and faces of all brick shall
12 be plane surfaces at right angles and parallel to each other.

13 Brick of the same manufacturer shall not vary more than $\pm 1/16$ " in thickness, $\pm 1/8$ " in width
14 and $\pm 1/4$ " in length.

15 Concrete brick may be used instead of clay or shale brick when designated in the plans or in
16 the specifications. Concrete brick shall meet ASTM C55 for Grade S-II except that the
17 absorption of brick used in minor drainage structures shall not exceed 10 lb/cf.

1040-2 CONCRETE BUILDING BLOCK

19 Use concrete building block from sources that participate in the Department's Solid Concrete
20 Masonry Brick/Unit QC/QA Program. A list of these sources in North Carolina and adjoining
21 states is available from the Materials and Tests Unit in Raleigh.

22 Use concrete building block that meets ASTM C90. Block shall be pink in color and
23 substantially free from chips and cracks.

24 Use solid concrete block instead of clay brick for minor drainage structures that meet
25 ASTM C139 except that the nominal dimensions shall be 4" x 8" x 16".

26 Concrete block for block manholes shall meet ASTM C139.

1040-3 CONCRETE PAVING BLOCK

28 Use concrete paving block from sources that participate in the Department's Solid Concrete
29 Masonry Brick/Unit QC/QA Program. A list of these sources in North Carolina and adjoining
30 states is available from the Materials and Tests Unit in Raleigh.

31 Use concrete paving block that meet ASTM C139, except that the nominal dimensions shall
32 be 4" x 8" x 16". The block shall have a uniform surface color and texture.

1040-4 SEGMENTAL RETAINING WALL UNITS

34 Use segmental retaining wall (SRW) units from sources that participate in the Department's
35 Solid Concrete Masonry Segmental Retaining Wall Units QC/QA Program. A list of these
36 sources in North Carolina and adjoining states is available from the Materials and Tests Unit
37 in Raleigh.

38 Use freeze-thaw durable SRW units when noted in the plans. Unless required otherwise in
39 the contract, provide SRW units with a vertical straight face and a concrete gray color with no
40 tints, dyes or pigments. Do not begin unit production until sample SRW units of the type,
41 face and color proposed for the project are approved.

42 Use SRW units that meet ASTM C1372 except for Table 1040-1 requirements.

**TABLE 1040-1
SRW UNIT REQUIREMENTS**

Property	Requirement	Test Method
Compressive Strength for SRW Units	4,000 psi min	ASTM C140
Compressive Strength for Freeze-Thaw Durable SRW Units	5,500 psi min	ASTM C140
Absorption	5% max	ASTM C140
Durability for Freeze-Thaw Durable SRW Units	1% maxA	ASTM C1262

1 **A.** Weight loss for 4 of 5 specimens after 150 cycles in water.

2 **1040-5 CEMENT**

3 Portland cement shall meet Article 1024-1.

4 Masonry cement shall meet ASTM C91.

5 **1040-6 HYDRATED LIME**

6 Hydrated lime shall meet ASTM C207 for Type N.

7 **1040-7 MORTAR SAND**

8 Mortar sand shall meet Article 1014-1, except it shall meet the gradation requirements for
9 No. 4S sand shown in Table 1005-2.

10 **1040-8 WATER**

11 Water shall meet Article 1024-4.

12 **1040-9 MORTAR**

13 Proportion mortar used in all brick and block masonry by volume as shown below. Do not
14 add any more water than is necessary to make a workable mixture.

Mix No. 1: 1 part Portland cement
 1/4 part hydrated lime
 3 3/4 parts mortar sand (maximum)

Mix No. 2: 1 part Portland cement
 1 part masonry cement
 6 parts mortar sand (maximum)

15 Apply Articles 1040-4, 1040-5, 1040-6 and 1040-7 to all cement, hydrated lime, mortar sand
16 and water.

17 For the hydrated lime and cement portion of Mix No. 1, the Contractor may substitute
18 Type M or Type S masonry cement that meets ASTM C270 for Type S masonry cement the
19 minimum compressive strength of the test specimens shall be 2,500 psi at 28 days and the test
20 specimens shall be composed of one part Type S masonry cement and 3 parts sand. Furnish
21 a Type 3 certification for the Type M or Type S masonry cement in accordance with
22 Article 106-3.

23

24

**SECTION 1042
RIP RAP MATERIALS**

25 Use field stone or rough unhewn quarry stone for plain rip rap. Use stone that is sound,
26 tough, dense, resistant to the action of air and water and suitable in all other respects for the
27 purpose intended. Where broken concrete from demolished structures or pavement is
28 available, it may be used in place of stone provided that such use meets with the approval of
29 the Engineer. However, the use of broken concrete that contains reinforcing steel will not be
30 permitted.

Section 1043

- 1 All stone shall meet the approval of the Engineer. While no specific gradation is required,
2 there shall be equal distribution of the various sizes of the stone within the required size
3 range. The size of an individual stone particle will be determined by measuring its long
4 dimension.
- 5 Stone or broken concrete for rip rap shall meet Table 1042-1 for the class and size
6 distribution.

Class	Required Stone Sizes, inches		
	Minimum	Midrange	Maximum
A	2	4	6
B	5	8	12
1	5	10	17
2	9	14	23

- 7 No more than 5.0% of the material furnished can be less than the minimum size specified nor
8 no more than 10.0% of the material can exceed the maximum size specified.

SECTION 1043 AGGREGATE FROM CRUSHED CONCRETE

1043-1 GENERAL

- 12 Aggregate from crushed concrete is a recycled product made by crushing concrete obtained
13 from concrete truck clean out, demolition of existing concrete structures or pavement, or
14 similar sources and transported from a crushing facility. It does not include concrete
15 pavements that are rubblelized, broken or otherwise crushed in place on the roadway.
- 16 The crushed material must meet all sources approval requirements described in Sections 1005
17 and 1006 with the exception of the sodium sulfate test requirement. Deleterious materials
18 shall not be more than 3%.
- 19 Sampling and acceptance for the determination of gradation, LL and PI will be performed as
20 described in the *Aggregate QC/QA Program Manual* and the *Aggregate Sampling Manual*.

1043-2 AGGREGATE BASE COURSE

- 22 The material shall meet the ABC gradation. The LL of the material shall be raised 5 points to
23 no more than 35.

1043-3 AGGREGATE SHOULDER BORROW

- 25 The material shall meet Section 1019.

1043-4 CLEAN COARSE AGGREGATE FOR ASPHALT

- 27 The material shall meet the gradation of a standard size in Table 1005-1. Use of the material
28 shall be approved by the Engineer, and the mix shall meet all requirements.

1043-5 CLEAN COARSE AGGREGATE FOR CONCRETE

- 30 The material shall meet the gradation of a standard size in Table 1005-1. Use of the material
31 is restricted to Class B concrete mixes only. Use of the material shall be approved by the
32 Engineer, and the concrete shall meet all requirements.

SECTION 1044 SUBSURFACE DRAINAGE MATERIALS

1044-1 SUBDRAIN FINE AGGREGATE

- 36 Subdrain fine aggregate shall meet No. 2S or 2MS in Table 1005-2.

1 1044-2 SUBDRAIN COARSE AGGREGATE

2 Subdrain coarse aggregate shall meet No. 78M in Table 1005-1.

3 1044-3 PIPE AND FITTINGS

4 Pipe and fittings may be, at the option of the Contractor, either concrete, corrugated steel,
5 bituminized fiber or corrugated plastic.

6 1044-4 CONCRETE PIPE AND FITTINGS

7 Non-perforated concrete pipe and pipe fittings shall meet AASHTO M 86 for standard
8 strength nonreinforced concrete pipe.

9 Perforated concrete pipe shall meet AASHTO M 175 for standard strength perforated
10 nonreinforced concrete underdrainage pipe.

11 Joint materials shall meet Section 1028.

12 1044-5 CORRUGATED STEEL PIPE AND FITTINGS

13 Non-perforated corrugated steel pipe and pipe fittings shall meet Subarticle 1032-3(A).

14 Perforated corrugated steel pipe shall meet AASHTO M 36.

15 Fabricate the corrugated steel pipe from steel sheets having a minimum thickness of 0.052".

16 1044-6 PVC PIPE

17 PVC pipe shall meet ASTM D1785.

18 1044-7 CORRUGATED PLASTIC PIPE AND FITTINGS

19 Corrugated plastic pipe and fittings shall meet AASHTO M 252 for heavy duty tubing, except
20 that the maximum stretch resistance shall be 10%.

21 1044-8 OUTLET PIPE

22 Outlets constructed of PVC Schedule 40 pipe shall meet ASTM D2665. HDPE pipe shall
23 meet AASHTO M 294, Type S.

24 **SECTION 1046**
25 **GUARDRAIL MATERIALS**

26 1046-1 GENERAL

27 Use guardrail materials from sources meeting requirements of the Department's Brand
28 Registration Program for guardrail. A list of these sources is available from the Materials and
29 Test Unit's Central Laboratory. The Department will remove a manufacturer of guardrail
30 materials from this program if the monitoring efforts indicated that non-specification material
31 is being provided or test procedures are not being followed.

32 The following types of guardrail materials and all associated accessories may be accepted
33 under this program: rail elements, posts and offset blocks, terminal sections, anchor units,
34 transition sections and hardware.

35 1046-2 RAIL ELEMENTS

36 The rail element and terminal sections shall meet AASHTO M 180 for Class A, Type 2.

37 1046-3 POSTS AND OFFSET BLOCKS**38 (A) General**

39 (1) The Contractor may furnish any one of the following types of steel guardrail posts.
40 Only one type of post will be permitted at any one continuous installation.

Section 1046

1 Use structural steel posts throughout the project, unless otherwise directed or
2 detailed in the plans.

3 (a) Steel W6 x 8.5 or W6 x 9.0 posts

4 (b) Steel 4.5" x 6.0" C-shape posts

5 (2) The Contractor may at his option furnish either of the following types of treated
6 timber posts if specifically directed or detailed in the plans. Only one type of post
7 will be permitted at any one continuous installation.

8 (a) Timber 6" x 8" posts

9 (b) Timber 8" x 8" posts

10 **(B) Structural Steel Posts**

11 Fabricate steel posts for guardrail of the size and weight shown in the plans from
12 structural steel complying with Section 1072. Metal from which C-shape posts are
13 fabricated shall meet ASTM A1011 for any grade of steel except that mechanical
14 requirements that shall meet ASTM A36. Punch or drill the holes for connecting bolts.
15 Burning will not be permitted. After fabrication the posts shall be galvanized in
16 accordance with Section 1076.

17 **(C) Treated Timber Posts**

18 Timber guardrail posts shall be of treated southern pine meeting Articles 1082-2
19 and 1082-3.

20 Bore bolt holes to a driving fit for the bolts. A minus tolerance of 1% will be allowed in
21 the length of the post. Perform all framing and boring before the posts receive
22 preservative treatment.

23 **(D) Offset Blocks**

24 Provide 8" deep recycled plastic or composite offset blocks approved for use with the
25 guardrail shown in the *Roadway Standard Drawings* or plans. Only one type of offset
26 block will be permitted at any one continuous installation. Before beginning the
27 installation of recycled offset block, submit the FHWA acceptance letter for each type of
28 block to the Engineer for approval.

29 Treated timber offset blocks with steel beam guardrail will not be allowed unless required
30 by Specifications, directed by the Engineer or detailed in the plans. Steel offset blocks
31 with steel beam guardrail will not be allowed.

32 Recycled plastic or composite offset blocks shall be made from no less than 50%
33 recycled plastic or composite and shall meet the requirements in Table 1046-1.

TABLE 1046-1 WIRE DIAMETER	
Property	Requirement
Minimum Specific Gravity	0.950
Min. Compressive Strength in Lateral Direction	1,600 psi
Maximum Water Absorption	10% by weight
Maximum Termite and Ant Infestation	10%
Testing	Pass NCHRP Report 350, Test Level 3 by Crash Testing
Approval	Approved for use by the FHWA

1 1046-4 HARDWARE

2 Provide all hardware as indicated in the plans that is galvanized in accordance with
3 ASTM A153.

4 1046-5 ANCHORS AND ANCHOR ASSEMBLIES

5 Each shipment of guardrail terminal end sections, anchors and anchor assemblies shall be
6 shipped from the manufacture with a current parts list and installation guide. Units not having
7 the above documents will be rejected.

8 Articles 1046-1, 1046-2 and 1046-3 are applicable to rail elements, terminal sections, posts,
9 offset blocks and hardware.

10 Reinforcing steel shall meet Article 1070-2. Steel plates shall meet ASTM A36. Anchor rods
11 shall meet ASTM A663 for Grade 65.

12 Anchor cable shall be 3/4" wire rope having a minimum breaking strength of 21.4 tons and
13 galvanized. Use commercial quality galvanized steel cable thimbles. Use commercial quality
14 drop forged galvanized steel cable clips. The fitting and stud for the anchor cable shall be
15 suitable for cold swaging and be galvanized. After being swaged on the cable, the fitting and
16 stud assembly, including swaged joint and cable, shall have a minimum breaking strength
17 of 21.4 tons.

18 Perform welding in accordance with Article 1072-18.

19 Welded components shall be galvanized after welding in accordance with ASTM A123. All
20 other metal parts shall be galvanized in accordance with ASTM A153, except where
21 otherwise specified in Articles 1046-1, 1046-2 and 1046-3.

22 1046-6 REPAIR OF GALVANIZING

23 Perform repair of galvanizing in accordance with Article 1076-7.

24 1046-7 CABLE GUIDERAIL

25 Posts, hardware and miscellaneous components shall meet the applicable requirements of this
26 Section, the plans and the manufacture's requirements.

27 Furnish cable guiderail manufactured in accordance with AASHTO M 30, Type 1, Class A.

28 For concrete anchors, furnish Class A concrete if cast in place or use concrete meeting
29 Section 1077, if using precast concrete anchors.

30 Cable guiderail is not covered under the Brand Certification Program for guardrail materials.
31 Sample cable guiderail according to the *Minimum Sampling Guide*.

32 1046-8 ACCEPTANCE

33 Acceptance of guiderail materials and its accessories will be based on, but not limited to,
34 visual inspections, classification requirements and check samples taken from material
35 delivered to the project and conformance to the annual Brand Registration. Guiderail
36 materials not meeting the above requirements will be rejected, unless written approval is
37 obtained from the State.

38 SECTION 1050
39 FENCE MATERIALS**40 1050-1 GENERAL**

41 All fence material and accessories shall be melted and manufactured in the USA.

Section 1050

1 (A) Chain Link Fence

2 Furnish either galvanized steel fence framework or aluminum alloy fence framework
3 unless otherwise specified. Use the same type of fabric and framework materials
4 throughout the project.

5 Where galvanized steel framework is used, the fence fabric may be either galvanized
6 steel or aluminum coated steel, except where galvanized steel fabric is specified in the
7 contract. The Contractor may furnish any of the following galvanized steel framework
8 systems:

9 System G1

Line Posts:	Steel Pipe
Terminal Posts (End, Corner, or Brace Posts):	Steel Pipe
Gate Posts, Double Gate:	Steel Pipe
Gate Posts, Single Gate:	Steel Pipe
Brace Rail and Top Rail ^A :	Steel Pipe

10 System G2

Line Posts:	Steel H Post
Terminal Posts (End, Corner, or Brace Posts):	Steel Pipe
Gate Posts, Double Gate:	Steel Pipe
Gate Posts, Single Gate:	Steel Pipe
Brace Rail and Top Rail ^A :	Steel Pipe

11 System G3

Line Posts:	Roll Formed Steel
Terminal Posts (End, Corner, or Brace Posts):	Steel Pipe
Gate Posts, Double Gate:	Steel Pipe
Gate Posts, Single Gate:	Steel Pipe
Brace Rail and Top Rail ^A :	Steel Pipe or Roll Formed Pipe

12 A. Top rail to be used instead of tension wire only where called for in the itemized
13 proposal.

14 Where an aluminum alloy framework is used, the fence fabric may be either aluminum
15 alloy or aluminum coated steel. The Contractor may furnish any of the following
16 aluminum alloy framework systems:

17 System A1

Line Posts:	Aluminum Post
Terminal Posts (End, Corner, or Brace Posts):	Aluminum Pipe
Gate Posts, Double Gate:	Aluminum Pipe
Gate Posts, Single Gate:	Aluminum Pipe
Brace Rail and Top Rail ^A :	Aluminum Pipe

18 System A2

Line Posts:	Aluminum H Post
Terminal Posts (End, Corner, or Brace Posts):	Aluminum Pipe
Gate Posts, Double Gate:	Aluminum Pipe
Gate Posts, Single Gate:	Aluminum Pipe
Brace Rail and Top Rail ^A :	Aluminum Pipe

19 A. Top rail to be used instead of tension wire only where called for in the itemized
20 proposal.

1 (B) Wire Gauge

TABLE 1050-1 WIRE DIAMETER	
Size Coated Wire, gauge	Nominal Diameter of Wire, inch
6	0.192
7	0.177
9	0.148
10 1/2	0.128
11	0.120
11 1/2	0.113
12	0.106
12 1/2	0.099
13	0.092
13 1/2	0.086
14	0.080
15 1/2	0.067
16 1/2	0.058

2 Whenever the term gauge is used in this section to refer to a size of wire, it will be
3 construed to mean the United States Steel Wire Gauge, SWG (U.S.), regardless of
4 whether or not the base metal of the wire is steel or a nonferrous metal.

5 **1050-2 TIMBER POSTS AND BRACES**

6 (A) General

7 Use treated southern pine meeting Articles 1082-2 and 1082-3 for all timber posts and
8 braces, except as otherwise specified herein. Posts and braces may be either round or
9 square provided that the same shape is used throughout the project for both the posts and
10 the braces. Post and brace sizes are shown in the plans in inches. The size refers to the
11 diameter for round pieces, or to the edge dimension for square pieces. Square posts and
12 braces shall be fully dressed S4S. An allowable tolerance of 1/2" scant for square pieces
13 will be permitted from the dimensions called for in the plans.

14 Cut round wood posts and braces from sound solid trees, free from short or reverse bends
15 in more than one plane. Do not use log veneer cores for posts and braces unless they
16 contain at least 1" of sapwood for their entire circumference on both ends. The post or
17 brace shall not deviate more than 1" at any point from a straightedge held longitudinally
18 against the piece.

19 All posts shall be free from ring shake, season cracks more than 1/4" wide, splits in the
20 ends and contain no unsound knots. Sound knots will be permitted provided the width of
21 the knot does not exceed 1/3 the diameter of the post where it occurs. Groups of knots or
22 any combination of defects that will impair the strength of the piece will not be permitted.
23 The pieces shall show not less than 3 annual rings per inch and not less than 30% of
24 summer wood.

25 A tolerance of 1" plus and 1/2" minus will be allowed for the diameter of round posts and
26 braces, measured at the small end after peeling. Where they are out of round, this
27 tolerance will apply to the smaller diameter, and the larger diameter shall not exceed the
28 smaller by more than 20%. The maximum rate of increase in diameter at the butt shall be
29 1 1/2" in 10 ft.

30 A minus tolerance of 1% will be allowed in the length of both round and square posts.
31 Cut the ends square.

Section 1050

1 (B) Optional Steel Posts and Braces

2 Steel posts and braces for woven wire fence instead of timber posts and braces are
3 permitted in areas located in or west of Vance, Franklin, Wake, Lee, Moore and
4 Richmond Counties. Use the same type of fence post and brace throughout the project.
5 The optional steel posts and braces shall meet Subarticle 1050-3(B).

6 1050-3 METAL POSTS AND RAILS

7 (A) Chain Link Fence

8 Posts shall meet AASHTO M 181 except as otherwise provided herein.

9 Steel H posts shall have a minimum yield strength of 45,000 psi and weigh 3.26 lb/ft.
10 Galvanize steel H posts in accordance with ASTM F1043 with a Type A coating.
11 Aluminum H posts shall weigh 1.25 lb/ft.

12 Roll formed steel line posts shall be a 1.625" x 1.875" section weighing 2.40 lb/lf after
13 galvanizing and be formed from 0.121" thick sheet having a minimum yield strength
14 of 45,000 psi. Roll formed steel brace rails and top rails shall be a 1.250" x 1.625"
15 section weighing 1.35 lb/lf after galvanizing and be formed from 0.080" thick sheet steel
16 having a minimum yield strength of 45,000 psi. Galvanize all roll formed members after
17 fabrication in accordance with ASTM F1043 with a Type A coating.

18 Vinyl coated posts shall be pipe posts meeting AASHTO M 181 with a fusion bonded
19 vinyl coating at least 6 mils thick. The vinyl shall meet Section 6 of AASHTO M 181, or
20 if a standard color not listed in AASHTO M 181 is used, the vinyl shall meet the color
21 requirements in ASTM F934, Table 1.

22 Furnish brace rails with suitable metal connections to fasten them securely to the posts.
23 Provide the top rail not less than 6" long with a thickness of at least 0.051" if steel,
24 or 0.062" if 6063-T6 aluminum alloy and in lengths of at least 15 ft. The complete top
25 rail assembly shall form a continuous rail passing through the top fittings of the line posts
26 and be furnished with suitable metal connections to fasten it to the posts at each end.

27 For pipe 1.90" O.D. and under, the outside diameter at any point shall not vary more than
28 1/64" over no more than 1/32" under the standard specified. For pipe 2.375" O.D. and
29 over, the outside diameter shall not vary more than $\pm 1\%$ from the standard specified nor
30 shall the minimum wall thickness at any point be more than 12.5% under the nominal
31 wall thickness specified.

32 A 10% minimum weight tolerance will be allowed for all steel posts and rails.

33 (B) Woven Wire Fence

34 Steel posts used instead of 4" timber posts shall be a standard studded T-section
35 7.5 ft long designed exclusively for use as a fence post and be equipped with a metal
36 anchor plate securely attached to the post. The T-posts shall weigh 1.33 lb/lf exclusive of
37 the weight of the anchor plate, and have a total weight, including anchor plate, of
38 10.65 lb. Nominal dimensions of the T-post shall be 1 3/8" wide and 1 3/8" deep.
39 A tolerance of $\pm 3/16$ " will be permitted from these nominal dimensions. The anchor
40 plate shall be sufficiently sturdy to withstand the strain of driving with no loss of
41 effectiveness, and have a minimum area of 14.0 sq.in.

42 Steel posts used instead of 5" timber posts may be either tubular posts or angle posts.
43 They shall be 8 ft long and be embedded in a concrete anchor at least 3.3 ft deep and
44 10" in diameter. Fit tubular posts with ornamental tops that fit over the top of the post to
45 cap against moisture. Fabricate the tubular posts from 2" diameter pipe meeting
46 AASHTO M 181 for Grades 1 or 2 metallic coated posts and rails. Fabricate angle posts
47 from angle sections measuring 2 1/2" x 2 1/2" x 1/4", $\pm 1/16$ " on the 2 1/2" dimensions
48 and ± 0.015 " on the 1/4" dimension and weighing 4.10 lb/ft.

1 Use steel braces with steel posts and either tubular braces or angle braces to match the
 2 posts. Furnish the braces with suitable metal connections to fasten them securely to the
 3 posts. Fabricate tubular braces from 1 1/4" diameter pipe meeting AASHTO M 181 for
 4 Grades 1 or 2 metallic coated posts and rails. Fabricate angle braces from angle sections
 5 measuring 2" x 2" x 1/4" ± 3/64" on the 2" dimensions and ± 0.010" on the
 6 1/4" dimension and weighing 3.19 lb/ft.

7 A 10% minimum weight tolerance will be allowed for all steel posts and braces.

8 For pipe 1.90" O.D. and under, the outside diameter at any point shall not vary more than
 9 1/64" over nor more than 1/32" under the standard specified. For pipe 2.375" O.D. and
 10 over, the outside diameter shall not vary more than ± 1% from the standard specified nor
 11 shall the minimum wall thickness at any point be more than 12.5% under the nominal
 12 wall thickness specified.

13 Galvanize all steel posts and braces other than tubular members in accordance with
 14 ASTM A123.

15 **1050-4 BARBED WIRE**

16 Barbed wire shall meet ASTM A121 except as otherwise provided in this subarticle.

17 The barbed wire may be either galvanized steel or aluminum coated steel except that where
 18 aluminum chain-link fabric is used, galvanized steel barbed wire shall not be used. Use the
 19 same type of material throughout the project. All barbed wire shall have 4 point barbs spaced
 20 not more than 5" apart. Single strand barbed wire will not be acceptable.

21 Two strand galvanized steel barbed wire shall be fabricated from either 12 1/2 gauge or
 22 15 1/2 gauge strand wire with 4 point galvanized steel 14 gauge barbs. The 12 1/2 gauge shall
 23 be Standard Grade with a Class 3 coating on the wire and a Class 1 coating on the barbs.
 24 The 15 1/2 gauge shall be Chain Link Fence Grade with a Class 3 coating on both the wire
 25 and barbs.

26 Two strand aluminum coated steel barbed wire shall be fabricated from 2 strands of
 27 12 1/2 gauge aluminum coated steel wire with the 4-point barbs being either 14 gauge
 28 aluminum coated steel or aluminum alloy wire.

29 **1050-5 WOVEN WIRE**

30 Woven wire fencing shall conform to ASTM A116 or AASHTO M 279. The fence fabric
 31 shall be 47" high, with 10 horizontal strands. Space the strands 3" apart at the bottom and
 32 8" apart at the top with progressive spacing between. Space vertical strands at 6" intervals.
 33 Any of the following styles and coating classes may be used.

34 (A) Style 1047-6-9, Grade 60 (all horizontal and vertical strands of wire shall be 9 gauge)
 35 with a Class 3 zinc coating.

36 (B) Style 1047-6-11, Grade 60 (top and bottom horizontal strands to be 9 gauge wire, all
 37 other strands to be 11 gauge) with a Class 3 zinc coating.

38 (C) Style 1047-6-12 1/2, Grade 125 (top and bottom horizontal strands of wire to be no
 39 smaller than 10 1/2 gauge with a minimum breaking strength of 1610 lb, all other strands
 40 to be no smaller than 12 1/2 gauge with a minimum breaking strength requirement for
 41 horizontal strands of 960 lb with a Class 3 coating.

42 Brace wire shall be a 9 gauge steel in accordance with ASTM A641, except that the minimum
 43 zinc coating shall be 0.80 oz/sf.

44 **1050-6 CHAIN LINK FABRIC**

45 Chain link fence fabrics shall meet AASHTO M 181. Galvanized steel fabric shall have
 46 a Class D coating. Polyvinyl coated fabric shall be Type IV, Class A or B and the vinyl
 47 coating shall be a standard color meeting AASHTO M 181 or ASTM F934 Table 1.

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1 Glare screen fabric with a 0.5" mesh shall have a Class 1 zinc coating in accordance with
2 ASTM A392. The height of the chain link fence fabrics shall be as shown in the pay item
3 description. Weave the fabric from 11 gauge wire, unless otherwise required by the contract.
4 Glare screen fabric shall be 11 1/2 gauge unless otherwise required by the contract.

5 **1050-7 FENCE FITTINGS, HARDWARE AND ACCESSORIES**

6 All fittings, hardware and accessories shall meet AASHTO M 181, AASHTO M 232,
7 ASTM F626 OR ASTM A641 or ASTM A809 except for the size, type and coating
8 requirement as shown below in Table 1050-2 and elsewhere in this article.

9 Galvanize bolts, nuts, washers and other threaded items in accordance with AASHTO M 232.

10 Where shown in the plans, fit the posts with ornamental tops. The base of tops to be used
11 with pipe posts shall fit over the top of the post to guard against moisture.

12 Tension wire for use with galvanized steel chain link fabric shall meet AASHTO M 181 for
13 zinc coated tension wire. Tension wire for use with aluminum or aluminum coated chain link
14 fabric may be either aluminum coated tension wire meeting AASHTO M 181, or solid
15 aluminum wire with a minimum diameter of 0.192". The aluminum for solid aluminum wire
16 shall meet ASTM B211 for Alloy 5056 or 6061, and have a minimum breaking strength of
17 1,216 lbf and a minimum elongation of 10%. Tension wire for use with guardrail mounted
18 glare screen fabric shall be 6 gauge and for barrier mounted glare screen the wire shall be
19 9 gauge unless otherwise required by the contract.

20 Vinyl coated fittings and accessories shall be galvanized steel or aluminum coated steel
21 meeting this article and have a bonded vinyl coating. The vinyl shall meet Section 6 of
22 AASHTO M 181 and be a standard color meeting AASHTO M 181 or ASTM F934 Table 1.
23 The vinyl coating shall be at least 6 mils thick, except that the coating on tension wire, hog
24 rings and tie wires shall be 6 to 10 mils thick.

25 **1050-8 REPAIR OF GALVANIZING**

26 Repair of galvanizing shall be in accordance with Article 1076-7. Do not use aerosol can
27 products for repairs

TABLE 1050-2 PROPERTIES OF FENCING MATERIALS				
Item	Gauge or Diameter, inch	Coating, oz/sf	Coating, oz/sf, Aluminum	Remarks
Tie wires, steel	9	0.90	0.40	For fastening chain link fabric and tension wire to tubular sections or to roll formed steel line posts.
Tie wires, Aluminum	6	-	-	Alloy 1350-H19 or approved equal.
Clips, steel wire	7	0.90	-	For fastening chain link fabric and tension wire to H- posts.
Clips, steel wire	11	0.85	-	For fastening woven wire fabric to steel posts.
Hog rings, steel	12	0.80	0.40	For fastening chain link fabric to tension wire.
Hog rings, aluminum	9	-	-	Alloy 1350-H19 or approved equal.
Truss rod, steel	5/16	2.00	-	-
Tension (stretcher) bars, steel	3/16 x 3/4	1.50	-	For connection of 1 3/4" or 2" fabric to end, gate and corner posts for fabric heights over 5 ft.
Tension (stretcher) bars, steel	3/16 x 5/8	1.50	-	For connection of 1 3/4" or 2" fabric to end, gate and corner posts for fabric heights up to 5 ft.
Tension (stretcher) bars, steel	1/4 x 3/8	1.50	-	For connection of 1" fabric to end, gate, and corner posts.
Staples, Nails or	9	0.35	-	For fastening woven wire to timber posts. Shall be the size and shape shown in the plans.
Tension wire braces	9	0.90	0.40	For woven wire fence.
Post and line caps	-	1.30	-	For installation on top of posts to guard against moisture.
Rail and brace ends (pressed steel or cast iron)	-	1.30	-	-
Top rail steel sleeves	0.051	1.30	-	For rail connections. shall be fabricated to prevent movement along the rail.
Tension band	14	1.30	-	For fastening tension bar to posts.
Brace band	12	1.30	-	For fastening rail to posts.
Barbed wire extension arms (pressed steel or cast iron)	14	1.30	-	Shall be fitted with clips or slots for attaching the barbed wire to the arms.
Hinges, latches	-	2.00	-	-

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SECTION 1052 SALT AND LIME STABILIZERS

1052-1 SODIUM CHLORIDE

Sodium chloride shall meet AASHTO M 143.

1052-2 CALCIUM CHLORIDE

Calcium chloride shall be Class S or L meeting AASHTO M 144.

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1 1052-3 LIME

2 (A) Chemical Requirements

3 Quicklime and hydrated lime for soil stabilization shall meet ASTM C977 except that it
4 shall contain at least 86% available calcium oxide (CaO) on an LOI-free basis.

5 (B) Physical Requirements

6 (1) Hydrated Lime

7 Hydrated lime shall have at least 85% passing a No. 200 sieve.

8 (2) Quicklime

9 Grade quicklime so 100% passes a 1/4" sieve.

10 (C) Sampling and Inspection

11 Furnish Type 1 or Type 2 material certifications with each shipment of lime attesting that
12 the lime meets the Specifications in accordance with Article 106-3; however, the material
13 will be subject to inspection, test or rejection by the Engineer at any time.

14 Lime from more than one source or more than one type may be used on the same project,
15 but the different limes shall not be mixed. Protect the lime from exposure until used and
16 sufficiently dry it to flow freely when handled.

17 SECTION 1054 18 DRAINS

19 1054-1 DECK DRAINS

20 Provide deck drains made of PVC pipe or of steel pipe. Use the type of pipe as shown in the
21 plans.

22 PVC pipe shall meet ASTM D1785 or D2665, and have four 1/2" square lugs shop glued at
23 approximately equal spacing around the pipe at 3" from the top end of each deck drain.

24 Steel pipe shall meet ASTM A53 for standard weight galvanized pipe.

25 1054-2 FUNNELS AND FUNNEL DRAINS

26 (A) Funnels

27 Fabricate funnels for corrugated aluminum alloy pipe from clad aluminum alloy sheets
28 meeting AASHTO M 196. Perform fabrication by riveting. The completed funnel shall
29 meet AASHTO M 196.

30 Fabricate funnels for corrugated steel pipe of steel meeting AASHTO M 218.
31 Fabrication may be by riveting or by welding. The completed funnel shall meet
32 AASHTO M 36.

33 (B) Funnel Drain Pipe, Elbows and Fittings

34 Funnel drain pipe, elbows and other fittings may be, at the option of the Contractor, either
35 corrugated aluminum alloy or corrugated steel. Corrugated aluminum alloy pipe, elbows
36 and other fittings shall meet Article 1032-2. Corrugated steel pipe, elbows and other
37 fittings shall meet Article 1032-3.

SECTION 1056 GEOSYNTHETICS

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1056-1 DESCRIPTION

4 The section addresses geosynthetics consisting of geotextiles and geocomposites to be used
5 for subsurface drainage, separation, stabilization, reinforcement, erosion control, filtration,
6 temporary silt fence and other applications in accordance with the contract.

7 Use geotextile fabrics that meet Article 4.1 of AASHTO M 288 and have been evaluated by
8 NTPEP. Use prefabricated geocomposite drain strips consisting of a non-woven
9 polypropylene geotextile bonded to one side of a high density polyethylene or polystyrene
10 drainage core, e.g., sheet drain.

11 1056-2 HANDLING AND STORING

12 Load, transport, unload and store geosynthetics so geosynthetics are kept clean and free of
13 damage. Label, ship and store geosynthetics in accordance with Section 7 of
14 AASHTO M 288. Geosynthetics with defects, flaws, deterioration or damage will be
15 rejected. Do not unwrap geosynthetics until just before installation. Do not leave
16 geosynthetics exposed for more than 7 days before covering except for geotextiles for erosion
17 control devices and mechanically stabilized earth (MSE) wall faces.

18 If necessary or required, hold geosynthetics in place with wire staples that meet
19 Subarticle 1060-8(D) or anchor pins. Use steel anchor pins with a diameter of at least 3/16"
20 and a length of at least 18" with a point at one end and a head at the other end that will retain
21 a steel washer with an outside diameter of at least 1.5".

22 1056-3 CERTIFICATIONS

23 Provide Type 1, Type 2 or Type 4 material certifications in accordance with Article 106-3 for
24 geosynthetics. Define "minimum average roll value" (MARV) in accordance with
25 ASTM D4439. Provide certifications with MARV for geosynthetic properties except as noted
26 in Tables 1056-1 and 1056-2. Test geosynthetics using laboratories accredited by the
27 Geosynthetic Accreditation Institute (GAI) to perform the required test methods. For testing
28 geosynthetics, define a "lot" as a single day's production.

29 1056-4 GEOTEXTILES

30 When required, sew geotextiles together in accordance with Article X1.1.4 of
31 AASHTO M 288. Provide sewn seams with seam strengths meeting the required strengths for
32 the geotextile type and class specified.

33 Provide geotextile types and classes in accordance with the contract. Use woven or
34 nonwoven geotextiles with properties that meet Table 1056-1. Define "machine direction"
35 (MD) and "cross-machine direction" (CD) in accordance with ASTM D4439.

Section 1060

**TABLE 1056-1
GEOTEXTILE REQUIREMENTS**

Property	Requirement (MARV ^A)					Test Method
	Type 1	Type 2	Type 3 ^B	Type 4	Type 5 ^C	
<i>Typical Application</i>	<i>Shoulder Drains</i>	<i>Under Rip Rap</i>	<i>Temporary Silt Fence</i>	<i>Soil Stabilization</i>	<i>Temporary MSE Walls</i>	
Elongation (MD & CD)	≥ 50%	≥ 50%	≤ 25%	< 50%	< 50%	ASTM D4632
Grab Strength (MD & CD)	90 lb	205 lb	100 lb	180 lb	-	ASTM D4632
Tear Strength (MD & CD)	40 lb	80 lb	-	70 lb	-	ASTM D4533
Puncture Strength	220 lb	440 lb	-	370 lb	-	ASTM D6241
Wide Width Tensile Strength @ Ultimate (MD & CD)	-	-	-	-	2,400 lb/ft (unless required otherwise in the contract)	ASTM D4595
Permittivity	0.20 sec ⁻¹	0.20 sec ⁻¹	0.05 sec ⁻¹	0.05 sec ⁻¹	0.20 sec ⁻¹	ASTM D4491
Apparent Opening Size ^D	#60	#60	#30	#40	#30	ASTM D4751
UV Stability (Retained Strength) ^E	50%	50%	70%	50%	50%	ASTM D4355

- 1 **A.** MARV does not apply to elongation
- 2 **B.** Minimum roll width of 36" required
- 3 **C.** Minimum roll width of 13 ft required
- 4 **D.** US Sieve No. per AASHTO M 92
- 5 **E.** After 500 hours of exposure

6 **1056-5 GEOCOMPOSITES**

7 Provide geocomposite drain strips with widths of at least 12" and cores that meet
8 Table 1056-2.

**TABLE 1056-2
CORE REQUIREMENTS**

Property	Requirement (MARV ^A)	Test Method
Thickness	1/4" - 1/2"	ASTM D5199
Compressive Strength	40 psi	ASTM D1621
Flow Rate (with gradient of 1.0)	5 gpm ^B	ASTM D4716

- 9 **A.** MARV does not apply to thickness
- 10 **B.** Per foot of width tested

**SECTION 1060
LANDSCAPE DEVELOPMENT MATERIALS**

13 **1060-1 GENERAL**

14 Supply certifications for all landscape development materials as required below. If no
15 certification is required, supply the Department with a statement certifying that all materials
16 conform to these Specifications and those of the NC Department of Agriculture or both. All
17 landscape development materials shall comply with all applicable Federal and State domestic
18 plant quarantines.

1 1060-2 FERTILIZER

2 The quality of all fertilizer and all operations in connection with the furnishing of this material
3 shall comply with the North Carolina Fertilizer Law and with the rules and regulations,
4 adopted by the North Carolina Board of Agriculture in accordance with said law, in effect at
5 the time of sampling. All fertilizer will be subject to sampling and testing by the Engineer, or
6 by an authorized representative of the North Carolina Department of Agriculture, or both.

7 Dry fertilizer shall be manufactured from cured stock. Care for the fertilizer during handling
8 and storing in such a manner that it will be protected against hardening, caking or loss of plant
9 food values. Pulverize any hardened or caked fertilizer to its original condition before using.

10 1060-3 LIMESTONE

11 The quality of all limestone and all operations in connection with the furnishing of this
12 material shall comply with the North Carolina Lime Law and with the rules and regulations,
13 adopted by the North Carolina Board of Agriculture in accordance with said law, in effect at
14 the time of sampling. All limestone will be subject to sampling and testing by the Engineer,
15 or by an authorized representative of the North Carolina Department of Agriculture, or both.

16 Limestone shall be agricultural grade ground limestone. Either dolomitic or calcitic limestone
17 may be used.

18 All limestone shall contain not less than 90% calcium carbonate equivalents. Dolomitic
19 limestone shall contain not less than 10% of magnesium. Grade dolomitic limestone so at
20 least 90% will pass through a U.S. Standard 20 mesh screen and at least 35% will pass
21 through a U.S. Standard 100 mesh screen. Grade calcitic limestone so at least 90% will pass
22 through a U.S. Standard 20 mesh screen and at least 25% will pass through a U.S. Standard
23 100 mesh screen. Where the current grading requirements of the North Carolina Board of
24 Agriculture are different from the above, the requirements of the Board of Agriculture will
25 apply.

26 During handling and storing, care for the limestone in such manner that it will be protected
27 against hardening or caking. Pulverize any hardened or caked limestone to its original
28 condition before using.

29 1060-4 SEED

30 The quality of all seed and all operations in connection with the furnishing of this material
31 shall comply with the North Carolina Seed Law and with the rules and regulations, adopted
32 by the North Carolina Board of Agriculture in accordance with said law, in effect at the time
33 of sampling, and with the quality requirements of the *Standard Specifications*. All seed will
34 be subject to sampling by the Engineer, or by an authorized representative of the North
35 Carolina Department of Agriculture, or both; and will be tested by the North Carolina
36 Department of Agriculture. Supplementary testing for seed germination may be performed by
37 the Engineer.

38 The quality of all seed will be based on the percentage of pure live seed, which will be
39 computed by multiplying the percentage of purity by the percentage of germination and
40 dividing the result by 100.

41 Seed shall have been approved by the North Carolina Department of Agriculture before being
42 sown. No seed will be accepted with a date of test more than 8 months before the date of
43 sowing, excluding the month in which the test was completed. Such testing, however, will
44 not relieve the Contractor from responsibility for furnishing and sowing seed that meets these
45 *Standard Specifications* at the time of sowing. The Engineer may retest seed for germination
46 after 5 months of storage; at the beginning of each normal seeding season for the particular
47 kind of seed involved or at any time that the condition of the seed appears to have
48 deteriorated.

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1 When a low percentage of germination causes the quality of the seed to fall below the
2 minimum pure live seed specified, the Contractor may elect, subject to the approval of the
3 Engineer, to increase the rate of application sufficiently to obtain the minimum pure live seed
4 content specified, provided that such an increase in the rate of application does not cause the
5 quantity of noxious weed seed per acre or square yard, as the case may be, to exceed the
6 quantity that would be allowable at the regular rate of application.

7 Furnish and deliver each of the species or varieties of seed in separate bags. If seed is to be
8 mixed before sowing, perform such mixing in a commercial seed mixing machine, or by
9 an equally thorough means, after sampling and testing have been completed.

10 During handling and storing, care for the seed in such a manner that it will be protected from
11 damage by heat, moisture, rodents or other causes.

12 **1060-5 MULCH FOR EROSION CONTROL**

13 Mulch for erosion control shall consist of grain straw, or other acceptable material, and be
14 approved by the Engineer before being used. All mulch shall be reasonably free from mature
15 seedbearing stalks, roots or bulblets of Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild
16 Onion, Crotalaria, Witchweed and an excessive amount of restricted noxious weeds as
17 defined by the North Carolina Board of Agriculture at the time of use of the mulch. Loose
18 and separate straw mulch that is matted or lumpy before being used.

19 Material for holding mulch in place shall be asphalt or other approved binding material.

20 **1060-6 SPRIGS**

21 Sprigs shall consist of freshly dug live stolons or rhizomes of permanent grasses, at least
22 2" in length, and be first class representatives of the required species or varieties specified in
23 the specifications. The areas from which sprigs are to be obtained shall be free from Johnson
24 Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Crotalaria, Witchweed and an excessive
25 amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture at
26 the time of digging the sprigs. The areas shall have been mowed and raked, burned off, or
27 otherwise prepared in a manner acceptable to the engineer before digging of sprigs begins.

28 **1060-7 SOD**

29 Sod shall consist of a live, dense, well-rooted growth of permanent grasses, free from Johnson
30 Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Crotalaria, Witchweed and an excessive
31 amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture at
32 the time of cutting the sod. Mow the area from which sod is to be obtained to a height of not
33 more than 2". Rake free of grass clippings and debris and otherwise prepared in a manner
34 satisfactory to the Engineer before cutting of sod begins.

35 Cut the sod into rectangular sections of sizes convenient for handling without breaking or loss
36 of soil. Cut it with a sod cutter or other acceptable means to a depth that will retain in the sod
37 practically all of the dense root system of the grass.

38 During wet weather, allow the sod to dry sufficiently before lifting to prevent tearing during
39 handling and placing. During extremely dry weather, water it before lifting if such watering
40 is necessary to insure its vitality and to prevent loss of soil during handling.

41 **1060-8 MATTING FOR EROSION CONTROL**

42 **(A) General**

43 Matting for erosion control shall be excelsior matting or straw matting. Furnish
44 a Type 3 material certification in accordance with Article 106-3 certifying that the
45 matting meets this article. Other acceptable material manufactured especially for erosion
46 control may be used when approved by the Engineer in writing before being used.
47 Matting for erosion control shall not be dyed, bleached or otherwise treated in a manner
48 that will result in toxicity to vegetation.

(B) Excelsior Matting

Excelsior matting shall consist of a machine produced mat of curled wood excelsior at least 47" in width and weigh 0.975 lb/sy with a tolerance of $\pm 10\%$. At least 80% of the individual excelsior fibers shall be 6" or more in length. Evenly distribute the excelsior fibers over the entire area of the blanket. Cover one side of the excelsior matting with an extruded plastic mesh. The mesh size for the plastic mesh shall be no more than 1" x 1".

(C) Straw Matting

Straw matting shall consist of a machine produced mat of 100% grain straw. The straw matting shall have a width of at least 48" and no more than 90" and weighing at least 0.50 lb/sy and no more than 0.75 lb/sy. Evenly distribute the straw over the entire area of the blanket. Cover one side of the blanket with photodegradable netting with a maximum mesh (netting) size of 0.75" x 0.75" sewn together with a degradable thread. The grain straw shall contain no weed seeds. Package each roll separately.

(D) Wire Staples

Staples shall be machine made of No. 11 gauge new steel wire formed into a U-shape. The size when formed shall be not less than 6" in length with a throat of not less than 1" in width.

1060-9 WATER

Water used in the planting or care of vegetation shall meet Class C fresh waters as defined in 15 NCAC 2B.0200.

1060-10 NURSERY GROWN PLANT MATERIALS**(A) General**

Use all plants as called for by the contract.

Container grown plants may be used instead of balled and burlapped plants or bare rooted plants provided written approval for such use has been obtained from Engineer.

Grading of plants, size of root balls and type and minimum dimensions of containers shall conform to the *American Standard for Nursery Stock*. Do not cut back plants from larger sizes to meet the sizes called for in the contract.

Botanical names referred to in the contract are taken from *Hortus Third, the Bailey Hortorium* (MacMillan Publishing Co., Inc.). All plants delivered shall be true to name. Each plant, or group of the same species, variety and size of plant, shall be legibly tagged with the name and size of the plant.

All plants shall be first-class representatives of their species or varieties. The root system shall be vigorous and well developed. The branch systems shall be of normal development and free from disfiguring knots, sun scald injuries, abrasions of the bark, dead or dry wood, broken terminal growth or other objectionable disfigurements. Trees shall have reasonably straight stems and be well branched and symmetrical in accordance with their natural habits of growth.

All plants shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the states of origin and destination, as well as with Federal regulations governing interstate movement of nursery stock. Any nursery stock used on highway landscape projects shall be accompanied by a valid copy of a certificate of inspection, which has been granted by the North Carolina Department of Agriculture, Entomology Division. Fire ant treatment certification, where applicable, is required.

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1 When nursery stock from other states is used on projects in North Carolina, this stock
2 shall be accompanied by a tag or certificate stating that the nursery stock has been
3 inspected and certified by an authorized official of the state of origin as apparently free
4 from injurious plant pests.

5 All plant materials are subject to inspection at any time by the Engineer. Any such
6 inspection before or during planting operations, however, will not be construed as final
7 acceptance of the plants involved.

8 All geophytes; bulbs, corms and tuberous plants; shall be synonymous to the term “plant”
9 within the contract. Examples include, but are not limited to, Narcissi (Daffodil), Tulipa
10 (Tulip), Iris and Canna; the terms “bulb”, “corm”, “tuber”; and specific plant names such
11 as “Daffodil”, “Tulip”, “Canna lily”, etc.

12 (B) Balled and Burlapped Plants

13 Dig plants to be balled and burlapped so as to retain a firm ball of soil and the plant’s
14 fibrous root system. The soil in the ball shall be the original and undisturbed soil in
15 which the plant has been grown. Dig, wrap, transport and handle the plant so the soil in
16 the ball shall not become frozen, loosened, cause stripping of the small feeding roots nor
17 movements of the soil away from contact with such roots.

18 (C) Container Grown Plants

19 Container grown plants shall be healthy, vigorous, well-rooted and established in the
20 container in which they are delivered. These plants shall be in the container long enough
21 for the fibrous roots to have developed so the root mass will retain its shape and hold
22 together when removed from the container. The container shall be sufficiently rigid to
23 firmly hold the soil protecting the root mass during transporting, handling and planting.
24 The soil shall not be allowed to become frozen.

25 (D) Bare Root Plants

26 Bare root plants shall have a heavy fibrous root system that has been developed by proper
27 cultural treatment. Dig, package, transport and handle bare root plants in a manner that
28 will prevent injury to or drying out of the trunks, branches or roots, or freezing of the
29 roots. Bare root plants damaged through improper handling, freezing, drying out, etc.
30 will result in rejection of material.

31 (E) Plant Substitution

32 No change in the *Standard Specifications* (species, variety, size, caliper, furnish) will be
33 made without written approval of the Engineer. Present all requests for substitutions in
34 writing and include a listing of the sources contacted in an attempt to secure specified
35 plant material. Requests for substitutions shall include the botanical name, common
36 name, cultivar, where applicable, size, caliper and furnish description of the proposed
37 substitute. No increase in compensation will be made to the Contractor as a result of the
38 use of approved substitute plants. The Department reserves the right to locate specified
39 plant material for the project when it has knowledge that specified material is available.

40 (F) Geophytes

41 Geophytes; bulbs, corms and tuberous plants; shall be healthy and free of disease caused
42 by fungi, nematodes, bacteria and wilt. Plants that are lightweight and lacking adequate
43 mass will result in rejection. Plants shall be firm and absent of discolored patches with
44 soft or spongy areas or signs of rot, slime or mold. Plants with new root growth will
45 result in rejection.

46 Dig, package, transport and handle these plants as to prevent injury, drying out, excessive
47 wetness or freezing. Damaged plants through improper handling, freezing, drying out or
48 excessive moisture will result in rejection.

1 All geophytes, bulbs, corms and tuberous plants shall be inspected for size and condition
2 and rejected plants shall be removed from the supply before planting.

3 **1060-11 MULCH FOR PLANTING**

4 Use mulch for planting as specified in the specifications, shown in the plans, or approved by
5 the Engineer. Mulch for planting shall not contain substances injurious to plants or which
6 will inhibit normal development and growth of plants. Mulch for a project shall come from
7 a single source, as approved by the Engineer, unless an additional source is submitted and
8 approved before use.

9 **1060-12 MATERIALS FOR STAKING OR GUYING**

10 **(A) Stakes**

11 Use stakes made of cypress, cedar, oak, locust or other acceptable wood free from defects
12 that would compromise the strength of the stake. Stakes shall be at least
13 2" x 2" (nominal). Use stakes of the size and length as shown in the plans.

14 **(B) Wire**

15 Wire shall be new soft No. 14 gauge steel wire or as shown in the plans.

16 **(C) Hose**

17 Hose to be used with wire shall have a minimum inside diameter of 1/2". All hose shall
18 be garden type hose composed of rubber and fabric, or as shown in the plans.

19 **(D) Other**

20 Other staking and guying materials may be used if a sample is submitted and approved by
21 the Engineer before use.

22 **1060-13 HERBICIDES**

23 The herbicide to be used for a particular application shall be as specified or approved by the
24 Engineer.

25 Herbicides shall be properly labeled and registered with the United States Department of
26 Agriculture and the North Carolina Department of Agriculture. A container shall contain only
27 the herbicide that meets the analysis guaranteed on the label. Keep all herbicides in such
28 original labeled containers until used.

29 Herbicide application shall only be conducted by individuals who possess a pesticide license
30 from the NC Department of Agriculture or individuals under their direction and who has read,
31 understands, and follows the herbicide labeling before applying the product.

32 **1060-14 COIR FIBER MAT**

33 Coir fiber mat shall consist of 100% coconut fiber (coir) twine woven into high strength
34 matrix. The coir fiber mat shall have a thickness of at least 0.30" and weigh at least 20 oz/sy.
35 The coir fiber mat shall have a tensile strength of at least 1,348 x 626 lb/ft and elongation of
36 no more than 34% x 38%. The coir fiber mat shall have a flexibility of
37 65,030 x 29,590 mg-cm. The coir fiber mat shall have an observed flow velocity of 11 ft/sec.
38 The coir fiber mat shall have a C-Factor of 0.002. The size of the coir fiber mat shall be
39 6.6 ft x 164 ft and the measured open area shall be 50%.

40 **1060-15 SPECIAL STILLING BASIN**

41 The special stilling basin shall be a bag constructed to a minimum size of 10 ft x 15 ft made
42 from a nonwoven fabric. It shall have a sewn-in 8" (maximum) spout for receiving pump
43 discharge. The bag seams shall be sewn with a double needle machine using a high strength
44 thread. The seams shall have a minimum wide width strength of 60 lb/in tested in accordance
45 with ASTM D4884.

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SECTION 1070 REINFORCING STEEL

1070-1 GENERAL

Store steel reinforcement on blocking at least 12" above the ground; protect the steel at all times from damage; and when placing in the work, ensure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials.

1070-2 DEFORMED STEEL BAR REINFORCEMENT FOR STRUCTURES

Supply deformed steel bar reinforcement conforming to ASTM A615 for Grade 60. Bend and cut during fabrication with tolerances in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute. Bend the bars cold to the details shown in the plans.

Weld steel bar reinforcement only where shown in the plans or approved by the Engineer. When welding steel bar reinforcement use bars conforming to ASTM A706.

1070-3 COLD DRAWN STEEL WIRE AND WIRE REINFORCEMENT

Provide cold drawn steel wire for use as spirals or in fabricated form for the reinforcement of concrete meeting AASHTO M 32. Epoxy coat all spacers on spirals when the spirals are epoxy coated.

Use smooth welded wire reinforcement conforming to AASHTO M 55.

Use deformed welded wire reinforcement conforming to AASHTO M 221.

1070-4 REINFORCING STEEL BAR SUPPORTS

Make all wire bar supports of smooth cold drawn industrial quality basic wire having a minimum tensile strength of 65,000 psi. When the legs of the bar supports are in contact with the forms, ensure that the entire leg of the bar support is stainless steel wire or a minimum thickness of 1/4" stainless steel at points of contact with the forms. Use stainless steel wire meeting ASTM A493 except having a minimum chromium content of 16% and a minimum tensile strength of 95,000 psi. Ensure that wire sizes, height tolerance, and leg spacing for wire bar supports are in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute.

As an option to the stainless steel wire for the legs of bar supports at points of contact with the forms, provide legs of cold drawn steel wire plastic protected in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute, except provide plastic protection by dipping or by premolded plastic tips. Do not use plastic legs molded to the top wire.

Use plastic bar supports meeting the requirements listed in the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute only when approved by the Engineer.

1070-5 PRESTRESSING STRAND

Use prestressing strands for use in prestressed concrete consisting of 7 wire strands, stress relieved after manufacture to remove internal stresses. Use the size and the grade of the strand as shown in the plans. Use strands conforming to AASHTO M 203 except provide a specimen for test purposes, if required, from each reel of cable instead of each 20 ton production lot.

For precast prestressed deck panels, use 3/8" round seven-wire stress-relieved Grades 250 or 270 prestressing strands meeting AASHTO M 203.

1 Mark the outer layer of each reel pack of strand with a wide color band as follows: white for
2 Grade 270 stress relieved strand, green for low relaxation strand, and a double marking of
3 green and red for special low relaxation strand. In addition, attach a metal tag to each reel
4 pack labeled in accordance with AASHTO M 203.

5 **1070-6 DOWELS AND TIE BARS FOR PORTLAND CEMENT CONCRETE**
6 **PAVEMENT**

7 Use smooth plain round steel dowel bars conforming to AASHTO M 31 Grade 60. Do not
8 use dowel bars with burred ends. A tolerance of $\pm 1/4"$ is permitted from the dowel length
9 required by the plans. A straightness tolerance of 0.075" from a straight line is permitted.

10 Epoxy coat all dowel bars in accordance with AASHTO M 284 and these provisions, with
11 a coating thickness of 7 to 13 mils after curing. Coated bars will be taken by the Engineer
12 from the production run on a random basis at the point of coating application for testing and
13 evaluation. The Engineer determines the sampling and testing schedule for the number and
14 frequency of tests for thickness of coating, adhesion of coating and holidays. At least one bar
15 for each 20 coated is tested for holidays and coating thickness. Perform at least 2 bend tests
16 for each 8 hours of production coating or any fraction thereof for determining that adhesion
17 and flexibility of the coating meets specification requirements. Payment is not made by the
18 Department for coated bars selected for testing and evaluation purposes at the point of coating
19 application. All coated bars are inspected at both the coating and fabrication shops. Furnish
20 a Type 1 material certification in accordance with Article 106-3 and attach it to a completed
21 Reinforcing Steel Certification, M&T Form 913, for all coated reinforcing bars before
22 cleaning and coating operations, of the time and location where the work is performed.
23 A blank Reinforcing Steel Certification, M&T Form 913, may be obtained from the Materials
24 and Tests Unit.

25 Use dowel assemblies for supporting dowel bars of rigid construction capable of holding the
26 dowel bars in proper position during placing of concrete, and of such design to permit
27 unrestricted movement of the pavement slab. Use wire for dowel assemblies meeting
28 AASHTO M 32. Use a dowel assembly that holds the dowels in the required position within
29 a tolerance of $\pm 1/4"$ in vertical and horizontal planes. Obtain written approval for the dowel
30 assembly before use.

31 Coat dowel bars and the entire dowel assembly with an approved wax base coating. Apply
32 the coating by dipping or spraying such that the wax coating on the dowel bars is of uniform
33 thickness sufficient to allow pulling of the dowel from the concrete as provided in
34 AASHTO T 253 and M254. Furnish to the Department for testing one dowel basket assembly
35 for each 200 assemblies incorporated into the project.

36 Use deformed tie bars conforming to AASHTO M 31 for Grade 40 or Grade 60.

37 **1070-7 EPOXY COATED REINFORCING STEEL**

38 **(A) General**

39 Coaters of epoxy coated reinforcing steel shall establish proof of their competency and
40 responsibility in accordance with the Concrete Reinforcing Steel Institute's Fusion
41 Bonded Epoxy Coating Applicator Plant Certification Program. Registration and
42 certification of the plant or shop under the CRSI Program and submission of the valid
43 annual certificate to the State Materials Engineer is required before beginning any
44 coating. The same requirement applies to coaters subcontracting work from the coater
45 directly employed by the contractor.

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1 Obtain approval of each coater and/or fabricator of epoxy coated reinforcing steel before
2 coating or fabricating bars. Approval is based upon the following:

3 (1) The coating applicator and/or fabricator establishing and maintaining an effective
4 quality control program and

5 (2) The coating applicator having equipment for cleaning, coating and/or fabricating that
6 produces coated material conforming to these *Standard Specifications*.

7 Include in requests for approval a well defined quality control program and direct the
8 requests to the State Materials Engineer. Before Department approval is issued, the
9 condition of equipment for blast cleaning, coating and/or fabricating material is evaluated
10 by the Engineer for determining the equipment capability of producing a coated product
11 conforming to the *Standard Specifications*. Lists of Department approved epoxy coating
12 and fabricating companies are available from the State Materials Engineer.

13 (B) Coating Materials

14 Obtain approval for the epoxy resin powder before use. A list of prequalified powder
15 sources is available from the State Materials Engineer.

16 Submit prequalified products other than those now approved for use to the State
17 Materials Engineer for approval. Requalify each product every 5 years and any time
18 a change is made in the manufacturing process or chemical composition of the epoxy
19 resin.

20 Use powdered resin of any color that provides contrast to the corroded or uncorroded
21 surface of the steel. Provide material of the same quality as that used for prequalification
22 tests and as represented by test reports forwarded to the State Materials Engineer.

23 Ensure the manufacturer of the epoxy resin supplies to the coating applier information on
24 the resin that is essential to the proper use and performance of the resin as a coating.
25 Ensure the manufacturer of the resin furnish the coating applier a written certification
26 signed by a responsible officer of the company that the material furnished for coating the
27 reinforced steel is the same formulation as that for which test reports were previously
28 submitted to the State Materials Engineer.

29 With each batch of coating material, furnish a written certification by the coating applier
30 to the Engineer which properly identifies the batch number, material, quantity
31 represented, date of manufacture, name and address of manufacturer and includes
32 a statement that the supplied coating material is the same composition as that
33 prequalified.

34 (C) Patching Material

35 Ensure the epoxy resin manufacturer supplies a prequalified and approved patching or
36 repair material that is compatible with the coating and inert in concrete. Ensure that the
37 material is suitable for making repairs with a minimum dry film thickness of 6 mils from
38 2 coats on damaged areas of the coating. Ensure that each coater, fabricator and
39 contractor has a copy of the manufacturer's written instructions for application of the
40 patching material and the instructions are closely followed during coating damage
41 repairs.

42 Apply 2 coats of patch material where needed with the second coat applied only after the
43 first coat dries to the touch. Do not apply any patch material when the surface
44 temperature of the steel or the air temperature is below 40°F. Do not ship or place steel
45 until the patch material is dry to the touch.

(D) Reinforcing Steel

Use coated steel reinforcing bars meeting AASHTO M 31, Grade 60 and free of contaminants such as oil, grease and paint. Use bars free of surface irregularities that produce holidays in the coating. Ensure the coater visually inspects the bars to avoid coating bars containing such surface irregularities. If the coater fails to detect surface irregularities that produce holidays in the coating, patch the holidays with 6 mils of patching material as specified in Subarticle 1070-7(C) to avoid rejection of the bars.

(E) Surface Preparation of Bars

Subject coated reinforcing steel surfaces to a very thorough blast (near white) cleaning, before coating. Ensure that the appearance of the surface after cleaning corresponds to ASTM D2200 and the pictorial standards of SSPC-VIS 1, degree of cleaning SSPC-SP 10. Produce a suitable anchor pattern profile by the cleaning media. A target profile depth of 1/3 of the coating thickness is considered a suitable anchor pattern.

Apply the coating to the cleaned surface as soon as possible after cleaning. Remove any formation of rust blooms on the cleaned bars by blast cleaning before application of the coating. However, never delay the coating more than 8 hours after cleaning unless otherwise permitted. Provide surface characteristics of the steel as described above at the time of coating.

After blast cleaning, and before application of the coating, remove all visible traces of grit and dust from the bars.

(F) Application of Coating

Apply the coating as an electrostatically charged dry powder sprayed into the grounded steel bar using an electrostatic spray gun. Apply the powder to either a hot or cold bar. Give the coated bar a thermal treatment as specified by the manufacturer of the epoxy resin that provides a fully cured and bonded finish coating. Control temperature as recommended by the manufacturer of the coating material to ensure a workmanlike finish without blistering or other defects. Completely coat all bars, including bar ends, with epoxy resin powder to the minimum thickness specified in Subarticle 1070-7(G).

Run the production line at such a speed as to provide proper cure time before quench by air or water.

(G) Quality Control Requirements

For acceptance purposes, ensure that each recorded film thickness measurement is in the range of 7 to 12 mils after cure, with the entire area of a bar having a minimum coating thickness of 7 mils.

A single recorded coated reinforcing bar thickness measurement is the average of 3 individual readings obtained from 3 adjacent areas on the body of the bar (3 adjacent areas between deformations). Obtain at least 5 recorded measurements approximately evenly spaced along each side of the test bar (at least 10 recorded measurements per bar).

Ensure the coating applicator visually inspects each coated bar after cure for continuity of coating and to ensure that the coating is free of holes, voids, contamination, cracks and damaged areas discernible to the unaided eye. In addition, no more than an average of 2 holidays per linear foot of bar are permitted providing the total quantity of holidays does not exceed 5 in any linear foot. Bars that contain no more than 5 holidays in any linear foot of bar are acceptable provided any holidays in excess of 2 per linear foot are coated with 6 mils of patching material specified in Subarticle 1070-7(C). Retest the bars after patching to confirm that no more than 2 holidays exist in any linear foot of bar.

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1 Ensure the coating applicator evaluates the adhesion of the coating on a representative
2 number of bars selected by the Engineer from each proposed shipment as specified in
3 Subarticle 1070-7(L). No visible cracks or disbonding of the coating are allowed when
4 tested in accordance with Subarticle 1070-7(H).

5 (H) Test Methods Required of the Coater

6 The thickness of the coating is measured on the body of the bar between the deformations
7 or ribs. Conduct non-destructive coating thickness measurements using magnetic gauges
8 in accordance with ASTM G12, with the following additions applicable to commercially
9 available pull-off gauges, and to fixed probe gauges with a magnetic field of vision not
10 exceeding 0.015" of steel depth; 0.015" is the minimum thickness of smooth steel to
11 which adding more material does not change the zero reading.

12 Perform gauge calibration with shims on a smooth, clean low-carbon steel plate with
13 minimum dimensions of 3" x 3 1/2", rather than on a cleaned reinforcing bar.

14 Determine a correction factor defining the effect of the bar preparation process as the
15 difference between (a) the average of 10 gauge readings on a cleaned, but uncoated
16 reinforcing bar of the size and lot coated, and (b) the average of 5 gauge readings on
17 a smooth mild steel plate. This correction factor is then subtracted from all subsequent
18 gauge readings on coated bars.

Bar No.	Mandrel Diameter, inch
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
14	17
18	23

19 Fixed probe gauges are checked to ensure that the force generated by the springloaded
20 probe housing is sufficient to ensure intimate contact between the probe tip and the
21 coatings of the curved bar surface. If intimate contact does not result, remove the probe
22 housing and use hand pressure to obtain valid indicated thickness readings.

23 As an option, use thumbwheel pulloff gauges to provide valid thickness measurements on
24 coated reinforcing bars with a deformation spacing which is less than the maximum outer
25 dimensions of the probe housing. Position the base of the probe housing against the top
26 of 2 adjacent deformations and extend the probe through the air gap to the body of the
27 bar. Hold the gauge very steady and apply continuous light downward pressure to the
28 housing during the measurement.

29 Use a 67.5V holiday detector equipped with a holiday marker in accordance with the
30 detector manufacturer's instructions. Maintain the detector in perfect working condition
31 at all times during the bar coating process. Immediately after coating, route each bar
32 through the detector for holiday detection. Bars containing more than five holidays in
33 a linear foot of bar or averaging more than 2 holidays per foot of bar are either rejected or
34 cleaned, recoated, and retested for holidays. A coating holiday for the purpose of this
35 specification is defined as a discontinuity in the applied coating that occurs during the
36 coating process that is detected either visually or electromechanically.

1 The adhesion of the coating is evaluated by bending production coated bars 120° (after
2 rebound) around a mandrel of specified size as prescribed in Table 1070-1. Conduct the
3 bend test at a uniform rate and take up to 90 seconds to complete. Place the
4 2 longitudinal deformations in a plane perpendicular to the mandrel radius, and maintain
5 the test specimen at thermal equilibrium between 68°F and 85°F. If the specimen for the
6 adhesion of coating shows evidence of cracking or debonding of the coating, conduct
7 2 retests on random samples. If the results of both retests meet the specified
8 requirements, the coated bars represented by the samples are acceptable.

9 The fracture or partial failure of the steel-reinforcing bar in the bend test for adhesion of
10 coating is not considered as an adhesion failure of the coating. If failure of the bar
11 occurs, test 2 check samples without bar failure.

12 Condition test bars at a temperature range of 68°F to 85°F. In cases of dispute, conduct
13 tests at 73°F and 50% relative humidity in accordance with recommended practices in
14 ASTM D3451.

15 (I) Handling and Identification

16 Provide padded contact areas for all systems for handling coated bars at the coating plant,
17 fabricator and project. Pad or suitably band all bundling bands to prevent damage to the
18 coating. Lift all bundles of coated bars with a strong back, spreader bar, multiple
19 supports or a platform bridge to prevent bar-to-bar abrasion from sag in the bundles of
20 coated bars.

21 (J) Fabrication of Steel-Reinforcing Bars After Coating

22 Protect drive rolls and automatic kick-off levers on shear beds, and drive pins, center pins
23 and back-up barrels on benders with a suitable covering to minimize damage during the
24 fabrication process. Note that these *Standard Specifications* permit no more than 5% of
25 the surface area of a bar to contain patching material. This includes patching due to
26 damage to the coating by the coater, fabricator, transporter and contractor.

27 Store coated bars as required by Subarticle 1070-7(M).

28 Ensure the fabricator maintains the identification of the coated bars and that the coated,
29 fabricated bars are identified with proper tags for final shipment to the job site.

30 Perform coating repairs as described in Subarticle 1070-7(K) with material specified in
31 Subarticle 1070-7(C).

32 Flame cutting of coated bars to the required dimensions is not permitted. Maintain any
33 mechanical device used for cutting the coated bars to required length in good working
34 order to minimize damaging the coating in the vicinity of the cut ends. Repair coating
35 damage in these areas as described in Subarticle 1070-7(K) with material specified in
36 Subarticle 1070-7(C).

37 (K) Procedures for Repair of Coating

38 Repair all coating damage of the reinforcing bars with material described in
39 Subarticle 1070-7(C) when coating bond loss and damage exist, including crushed
40 coating and hairline cracking if bare metal is evident. When repair is required, clean and
41 repair all damage. Remove crushed coating and loose or deleterious material. In areas
42 where rust is present, remove it by wire brushing with a power tool to the surface finish
43 specified in Subarticle 1070-7(E) before repair.

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1 (L) Inspection by the Department

2 Coated bars are inspected at both the coating and fabrication shops unless otherwise
3 approved. The coater and/or fabricator shall furnish Type 3 material certification in
4 accordance with Article 106-3, attached to a completed Reinforcing Steel Certification,
5 M&T Form 913, for all coated reinforcing bars. Include a completed Epoxy Coated
6 Reinforcing Bar Inspection Report, Form 310, with each shipment. These certification
7 forms are available from the State Materials Engineer. Do not epoxy coat, fabricate or
8 ship reinforcing steel to the project site without the approval of the Engineer.

9 Provide free entry to the plant and facilities of the coater and/or fabricator for the
10 inspection of all manufacturing processes including, but not limited to, the cleaning,
11 coating and fabrication of the ordered bars.

12 On a random basis, lengths of coated bars or fabricated bars are taken from the
13 production run at the point of coating application for testing and evaluation.

14 All bar tests are made at the coating applicator and/or fabricator's plant, before shipment,
15 unless otherwise approved. Ensure the coating applicator and/or fabricator notify the State
16 Materials Engineer 5 working days before the time the material is coated or fabricated.
17 Do not ship bars until they are inspected and tagged by the Department.

18 The Engineer randomly selects 3 coated bars of each size from each proposed shipment
19 to test for holidays, damage and coating thickness. If any bar fails to conform to these
20 Specification requirements, 6 samples are selected and tested. If these tests reveal that
21 the coating conforms to Specification requirements the shipment is acceptable. If any of
22 the second set of samples fail to conform to these Specifications the coater is required to
23 test all bars of that size that are included in the shipment and re-submit the shipment to
24 the Department for inspection. The Engineer selects from each proposed shipment
25 2 samples of each size bar for bend tests by the coater for determining that the adhesion
26 and flexibility of the coating conforms to Subarticle 1070-7(H).

27 (M) Repairs to Coating Due to Loading, Transporting and Handling

28 Transport the bundled bars from the coater or fabricator to the project site with padding,
29 such as carpet padding or used carpet, placed over each bundle of steel upon which
30 another bundle of steel is placed unless wooden spacers are placed between each bundle
31 to prevent contact.

32 Load all bundles of bars horizontally for transporting. Transport the bars on a flatbed
33 trailer. Do not allow the length of bars extending beyond the trailer bed to exceed 8 ft.

34 Repair coating damage due to handling and transporting or other causes with material
35 specified in Subarticle 1070-7(C) and in accordance with Subarticle 1070-7(K).

36 (N) Rejection

37 Coated bars that do not meet the *Standard Specifications* are rejected. At the
38 Contractor's option, replace coated bars containing defects beyond the limits of the
39 *Standard Specifications*. Alternatively, strip the bars of coating, reclean and recoat in
40 accordance with the *Standard Specifications*.

41 1070-8 SPIRAL COLUMN REINFORCING STEEL

42 Furnish spiral column reinforcing steel with the following areas and weights as required in
43 Table 1070-2 and in the plans.

TABLE 1070-2			
SPIRAL COLUMN REINFORCEMENT STEEL PROPERTIES			
Material	Size	Area, sq.in.	Weight, lb/ft
Plain Cold Drawn Wire	W 20	0.20	0.668
	W 31	0.31	1.043
Deformed Cold Drawn Wire	D-20	0.20	0.680
	D-31	0.31	1.054
Plain or Deformed Bar	#4	0.20	0.668
	#5	0.31	1.043

1 Use cold drawn wire conforming to AASHTO M 32. Use plain or deformed bars conforming
2 to AASHTO M 31 for Grade 60. Use deformed cold drawn wire conforming to
3 AASHTO M 225.

4 The diameter of the spiral reinforcing steel is the outside to outside measurement of the bars
5 or wire, with an allowance of 1/2" more or 1/2" less than the specified diameter as shown in
6 the plans.

7 Furnish spirals with 1.5 extra turns at top and at bottom of the completed spiral cage. Where
8 splicing of the spirals is necessary other than those shown in the plans, provide a minimum
9 lap splice of 3 ft.

10 Do not weld on the spiral reinforcing steel.

11 When required by the plans, use epoxy coated spiral column reinforcing steel including
12 spacers in accordance with Article 1070-7.

13 Use the minimum number of spiral spacers as shown in the plans. Ensure a minimum section
14 modulus per spiral spacer of 0.030 cu.in.

15 **1070-9 MECHANICAL BUTT SPLICES**

16 When called for by the contract or when directed by the Engineer, use a mechanical butt
17 reinforcing steel splice from an approved source. Use a standard metal filled sleeve, cement
18 mortar filled sleeve, threaded steel couplings, forged steel sleeve or cold-forged sleeve.
19 An exothermic process whereby molten filler metal, contained by a high strength steel sleeve
20 of larger inside diameter than the bars, is introduced into the annular space between the bars
21 and the sleeve and between the ends of the bars may be used. Provide a splice that is capable
22 of transferring at least 125% of the yield strength of the bars from one bar to the other by the
23 mechanical strength of the splice components.

24 For splices not on the approved list, before use and as a condition of approval, assemble 3 test
25 splices in the presence of the Engineer for each size of bar which is proposed for use on the
26 project. Forward the test splices to the Materials and Tests Unit in Raleigh, NC for testing
27 and approval.

28 **SECTION 1072**

29 **STRUCTURAL STEEL**

30 **1072-1 GENERAL**

31 Furnish and fabricate all structural steel and related incidental materials including sign
32 supports and high mount lighting standards and use materials in accordance with this section.

33 **(A) Fabricator Qualification**

34 Use steel fabricators on the Department's Approved Structural Steel Fabricators List for
35 the type work being performed. The list is available from the Materials and Tests Unit or
36 on the Department's website.

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1 Employ fabricators of high mount lighting standards in excess of 80 ft in length,
2 structural steel components of fender systems, retaining walls and noise walls, sign
3 supports, sign structures, pot and expansion bearings, simple span rolled beams,
4 including those requiring cover plates, solar array platforms and modular expansion joints
5 that are AISC certified in Simple Steel Bridges. Employ fabricators of heat curved rolled
6 beams, rolled beams for continuous spans and plate girders that are AISC certified in
7 Major Steel Bridges. Employ fabricators of fracture critical bridge beams and girders
8 that have a Fracture Critical Members Endorsement from AISC. Ensure that fabricators,
9 applying over 1,500 sf of coating for each project, have a Sophisticated Paint System
10 Endorsement from AISC or a Quality Procedure 3 Certification from the Society of
11 Protective Coatings.

12 When AISC certification is required, submit proof of registration and certification of the
13 plant or shop under the AISC program to the State Materials Engineer before beginning
14 fabrication and on an annual basis. The same requirements apply to fabricators
15 subcontracting work from the fabricator directly employed by the Contractor.

16 **(B) Office**

17 Ensure that fabricators of main structural steel components of bridges provide an office
18 area with an approximate floor space of 100 sf, a desk or drafting table, 2 chairs,
19 telephone, facilities for proper heating and cooling, telephone, separate dial-up or faster
20 internet access and adequate lighting and located at the plant site for the exclusive use of
21 the Engineer. Ensure fabricators of other structural steel items furnish reasonable work
22 areas for the Engineer.

23 **1072-2 SHAPES, PLATES, BARS AND SHEETS**

24 Use shapes, plates, bars and sheets meeting AASHTO M 270 Grade 36 unless otherwise
25 required by the contract. For painted beams or girders, use sheet material of 1/32" in
26 thickness meeting ASTM A1008 or A1011, and sheet material of 1/16" through 5/32"
27 thickness meeting ASTM A1011 for Grades 36, 40 or 45. For unpainted beams or girders,
28 use sheet material less than 3/16" thickness meeting ASTM A606 for Type 4.

29 **1072-3 BEARING PLATE ASSEMBLIES**

30 Unless otherwise shown in the plans, galvanize steel bearing assemblies for both structural
31 steel beams and girders and prestressed concrete girders. Galvanize anchor bolts, nuts and
32 washers in accordance with AASHTO M 232. Cut pipe sleeves and collars from Schedule 40
33 PVC pipe meeting ASTM D1785.

34 Except for attachments of bearing plates to beams, fabricate and weld bearing plate
35 assemblies before galvanizing the steel. Seal all joints of welded parts with weld material.
36 After the fabrication of the bearing plate assembly is complete, galvanize the assembly in
37 accordance with AASHTO M 111. For prestressed concrete girders, clean welds made for
38 attaching bearing plates to beams or girders and give them 2 coats of organic zinc repair paint
39 having a minimum total coating thickness of 3 dry mils. For steel beams and girders, clean
40 and paint in accordance with Article 442-10.

41 Repair galvanized surfaces that are abraded or damaged at any time after the application of
42 the zinc coating by thoroughly wire brushing the damaged areas and removing all loose and
43 cracked coating, after which give the cleaned area 2 coats of organic zinc repair paint having
44 a minimum total coating thickness of 3 dry mils.

45 Use zinc rich paint meeting Article 1080-9.

46 **1072-4 ANCHOR BOLTS**

47 Unless otherwise stated herein, use anchor bolts meeting ASTM A307 for Grade A.

48 Provide anchor bolts for bearing plate assemblies meeting ASTM A449.

1 Swedge anchor bolts for a distance equal to the embedment length minus 3" measured from
2 the embedded end.

3 Hot-dip galvanize anchor bolts, nuts and washers in accordance with AASHTO M 232.

4 **1072-5 HIGH STRENGTH BOLTS, NUTS AND WASHERS**

5 **(A) General**

6 Furnish all high-strength bolts, nuts and washers, including direct tension indicators, in
7 accordance with the appropriate AASHTO or ASTM materials specifications as amended
8 and revised herein.

9 Furnish the Engineer a copy of the manufacturer's test report for each component.
10 Ensure the report indicates the testing date, the city and state where the components were
11 manufactured, the lot number of the material represented, the rotational capacity tests lot
12 number and the source identification marking used by the manufacturer of each
13 component. On test reports for direct tension indicators, include the tension load at
14 which indicators are tested, gap clearance, nominal size and coating thickness.

15 Produce each permanent fastener component installed in a structure from domestically
16 processed material containing the grade identification markings required by the
17 applicable reference specification and the manufacturer's source identification marking.
18 A copy of the source identification marking used by each manufacturer is on file with the
19 Department's Materials and Tests Unit.

20 Obtaining permanent bolts, nuts and washers in any one structure from different
21 manufacturers is allowed provided:

22 (1) All bolts are produced by only one manufacturer.

23 (2) All nuts are produced by only one manufacturer.

24 (3) All washers are produced by only one manufacturer.

25 Have all fasteners used in a structure furnished by the fabricator of the steel. Require the
26 fabricator to submit the fasteners for sampling and testing at least 5 weeks before delivery
27 to the project site. Sample and test each diameter and length of bolt, nut and washer
28 assembly in accordance with Table 1072-1.

TABLE 1072-1	
SAMPLING REQUIREMENTS FOR	
HIGH STRENGTH BOLTS, NUTS AND WASHERS	
Lot Quantity	Number of Samples
0-800	3 Assemblies
801-8000	6 Assemblies
> 8000	9 Assemblies

29 Ship only those fasteners to the project that are sampled, tested and approved. Protect the
30 material from moisture during storage such that it does not contain any indication of rust
31 at the time of installation. Ensure that each component contains a thin coat of lubricant at
32 the time of installation.

33 When galvanized high strength bolts are required, use bolts, nuts and washers meeting
34 Subarticle 1072-5(F).

35 When corrosion resistant structural steel is required by the plans, provide fasteners with
36 atmospheric corrosion resistance and weathering characteristics comparable to that of the
37 structural steel.

38 **(B) Specifications**

39 Ensure that all bolts meet ASTM A325.

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1 Ensure that all nuts meet ASTM A194 as applicable or ASTM A563. Completely coat
2 each nut with a wax lubricant.

3 Ensure that all washers meet ASTM F436.

4 Ensure that all direct tension indicators meet ASTM F959.

5 (C) Manufacturing

6 (1) Bolts

7 Hardness for bolt diameters 1/2" to 1" inclusive shall be 248 to 311 Brinell hardness
8 and 24 to 33 Rockwell C hardness.

9 (2) Nuts

10 (a) Heat treat galvanized nuts to Grades 2H, DH or DH3.

11 (b) Use plain (ungalvanized) nuts of Grades 2, C, D or C3 with a minimum
12 Rockwell hardness of 89 HRB or Brinell hardness of 180 HB, or heat treat to
13 Grades 2H, DH or DH3. The hardness requirements for Grades 2, C, D and C3
14 exceed the current AASHTO/ASTM requirements.

15 (c) Tap oversize galvanized nuts the minimum amount required by ASTM A563.
16 Overtap the nut such that the nut assembles freely on the bolt in the coated
17 condition and meets mechanical requirements of ASTM A563 and the
18 rotational-capacity test herein.

19 (3) Mark all bolts, nuts and washers in accordance with the appropriate
20 AASHTO/ASTM Specifications.

21 (4) Direct Tension Indicators

22 (a) For Type 3 high strength bolts, mechanically galvanize direct tension indicators
23 to ASTM B695, Class 55, and then apply baked epoxy to a thickness of 1 mil
24 minimum. Direct tension indicators need not be mechanically galvanized or
25 epoxy coated if they are made from material conforming to ASTM A325,
26 Type 3 bolts.

27 (b) For plain Type 1 high strength bolts, provide direct tension indicators that are
28 plain or mechanically galvanized to ASTM B695, Class 55.

29 (c) For galvanized Type 1 high strength bolts, mechanically galvanize direct tension
30 indicators to ASTM B695, Class 55.

31 (D) Testing

32 (1) Bolts

33 (a) Proof load tests in accordance with ASTM F606, Method 1, are required at the
34 minimum frequency as specified in AASHTO M 164, Paragraph 9.2.4.

35 (b) Wedge tests on full size bolts in accordance with ASTM F606, Paragraph 3.5,
36 are required. If bolts are galvanized, perform the tests after galvanizing. Test at
37 a minimum frequency as specified in AASHTO M 164, Paragraph 9.2.4.

38 (c) If galvanized bolts are supplied, measure the thickness of the zinc coating. Take
39 measurements on the wrench flats or top of bolt head.

40 (2) Nuts

41 (a) Proof load tests in accordance with ASTM F606, Paragraph 4.2, are required at
42 the minimum frequency of as specified in ASTM A563 and ASTM A194. If
43 nuts are galvanized, perform the tests after galvanizing, overlapping and
44 lubricating.

- 1 (b) If galvanized nuts are supplied, measure the thickness of the zinc coating. Take
2 measurements on the wrench flats.
- 3 (3) Washers
- 4 (a) If galvanized washers are supplied, perform hardness testing after galvanizing.
- 5 (b) Remove the coating before taking hardness measurements.
- 6 (c) If galvanized washers are supplied, measure the thickness of the zinc coating.
- 7 (d) Test direct tension indicators in accordance with ASTM F959.
- 8 (4) Assemblies
- 9 Rotational-capacity tests are required. Ensure the manufacturer or distributor
10 perform such tests on all black or galvanized (after galvanizing) bolt, nut and washer
11 assemblies before shipping. Washers are required as part of the test.
- 12 The following applies:
- 13 (a) Except as modified herein, perform the rotational-capacity test in accordance
14 with ASTM A325.
- 15 (b) Test each combination of bolt production lot, nut lot and washer lot as
16 an assembly. Where washers are not required by the installation procedures,
17 do not include in the lot identification.
- 18 (c) Assign a rotational-capacity lot number to each combination of lots tested.
- 19 (d) The minimum frequency of testing is 2 assemblies per rotational-capacity lot.
- 20 (e) Assemble the bolt, nut and washer assembly in a Skidmore-Wilhelm Calibrator
21 or an acceptable equivalent device (This requirement supersedes the current
22 ASTM A325 requirement to perform the test in a steel joint). For short bolts
23 that are too short for assembly in the Skidmore-Wilhelm Calibrator, see
24 Subarticle 1072-5(D)(4)(i).
- 25 (f) The minimum rotation, from a snug tight condition (10% of the specified proof
26 load), is: 240° (2/3 turn) for bolt lengths less than 4 diameters; 360° (1 turn) for
27 bolt lengths greater than 4 diameters and less than 8 diameters; 480° (1 1/3 turn)
28 for bolt lengths greater than 8 diameters.
- 29 (g) These values differ from the AASHTO M 164 Table 8 specifications.
- 30 (h) Achieve tension at the above rotation equal to or greater than 1.15 times the
31 required installation tension. The installation tension and the tension for the turn
32 test are shown in Table 1072-2.

Diameter, inch	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"
Req. Installation Tension, kips	12	19	27	39	51	56	71	85	103
Turn Test Tension, kips	14	22	32	45	59	64	82	98	118

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- 1 (i) After the required installation tension listed in Table 1072-2 is exceeded, one
2 reading of tension and torque is taken and recorded. The torque value shall
3 conform to the following equation:

$$\text{Torque} \leq 0.25(P \times D)$$

Where:

Torque = measured torque in foot-pounds
P = measured bolt tension in pounds
D = bolt diameter in feet

- 4 For bolts that are too short to test in a Skidmore-Wilhelm Calibrator, test in
5 a steel joint. The tension requirement of Subarticle 1072-5(D)(4)(h) is
6 computed using a value of **P** equal to the turn test tension shown in the
7 Table 1072-2.

8 (5) Reporting

- 9 (a) Record the results of all tests, including zinc coating thickness, required herein
10 and in the appropriate AASHTO specifications on the appropriate document.
11 (b) Report the location where tests are performed and date of tests on the
12 appropriate document.

13 (6) Witnessing

- 14 Witness of the test by an inspection agency is not required; however, ensure the
15 manufacturer or distributor performing the tests certifies that the recorded results are
16 accurate.

17 (7) Documentation

18 (a) Mill Test Report(s)

- 19 (i) Furnish Mill Test Report(s) for all mill steel used in the manufacture of the
20 bolts, nuts or washers.
21 (ii) Indicate in the Mill Test Report the place where the material was melted
22 and manufactured, the lot number of the material represented and the source
23 identification used by the manufacturer.

24 (b) Manufacturer Certified Test Report(s)

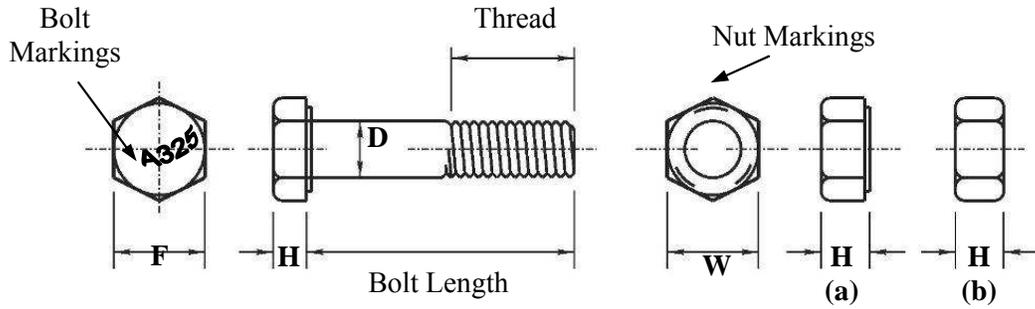
- 25 (i) Have the manufacturer of the bolts, nuts and washers furnish Manufacturer
26 Certified Test Report(s) for the item furnished.
27 (ii) Include in each Manufacturer Certified Test Report the relevant information
28 required in accordance with Subarticle 1072-5(D)(5).
29 (iii) Have the manufacturer performing the rotational-capacity test include on
30 the Manufacturer Certified Test Report:
31 A) The lot number of each of the items tested.
32 B) The rotational-capacity lot number as required in
33 Subarticle 1072-5(D)(4)(c).
34 C) The results of the tests required in Subarticle 1072-5(D)(4).
35 D) The pertinent information required in Subarticle 1072-5(D)(5)(b).
36 E) A statement that the Manufacturer Certified Test Report for the items
37 are in conformance to the *Standard Specifications* and the appropriate
38 AASHTO specifications.
39 F) The location where the bolt assembly components were manufactured.

- 1 (c) Distributor Certified Test Report(s)
- 2 (i) Ensure that the Distributor Certified Test Report(s) includes Manufacturer
- 3 Certified Test Reports above for the various bolt assembly components.
- 4 (ii) Ensure the rotational-capacity test is performed by a distributor or
- 5 a manufacturer and reported on the Distributor Certified Test Report.
- 6 (iii) Include in the Distributor Certified Test Report the results of the tests
- 7 required in Subarticle 1072-5(D)(4).
- 8 (iv) Include in the Distributor Certified Test Report the pertinent information
- 9 required in Subarticle 1072-5(D)(5)
- 10 (v) Include in the Distributor Certified Test Report the rotational-capacity lot
- 11 number as required in Subarticle 1072-5(D)(4)(c).
- 12 (vi) Ensure that the Distributor Certified Test Report certifies that the
- 13 Manufacturer Certified Test Reports are in conformance to this *Standard*
- 14 *Specifications* and the appropriate AASHTO specifications.

15 **(E) Shipping**

- 16 (1) Ship bolts, nuts and washers, where required, from each rotational-capacity lot in the
- 17 same container. If there is only one production lot number for each size of nut and
- 18 washer, shipping of the nuts and washers in separate containers is allowed.
- 19 Permanently mark each container on the side with the rotational-capacity lot number
- 20 such that identification is possible at any stage before installation.
- 21 (2) Provide the appropriate MTR and MCTR or DCTR to the contractor or owner as
- 22 required by the contract.

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1 **Figure 1072-1. Bolt and nut description.** Bolt and nut marking varies. Refer to
 2 Subarticle 1072-5(B). **F** is the width across the flats of the bolt. **H** is the height of the bolt or
 3 nut. Nuts may be washer facing as in (a) or double chamfered as in (b). **D** is the bolt
 4 diameter and nominal bolt size. **W** is the width across the flats of the nut.

Nominal Bolt Size, inch	Heavy Hexagon Structural Bolt Dimensions, inch			Semi-Finished Heavy Hexagon Nut Dimensions, inch	
	Width Across Flats	Height	Thread Length	Width Across Flats	Height
<i>(D)</i>	<i>(F)</i>	<i>(H)</i>	<i>(Thread)</i>	<i>(W)</i>	<i>(H)</i>
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	1 7/64
1 1/4	2	25/32	2	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32

TABLE 1072-4 HIGH STRENGTH BOLTS WASHER DIMENSIONS							
Bolt Size D, inch	Circular Washers Dimensions, inch				Square or Rectangular Beveled Washers Dimensions for American Standard Beams and Channels, inch		
	Nominal Outside Diameter	Nominal Diameter of Hole	Thickness Min.	Thickness Max.	Minimum Side Dimension	Mean Thickness	Slope of Taper in Thickness
1/2	1 1/16	17/32	.097	.177	1 3/4	5/16	1:6
5/8	1 5/16	11/16	.122	.177	1 3/4	5/16	1:6
3/4	1 15/32	13/16	.122	.177	1 3/4	5/16	1:6
7/8	1 3/4	15/16	.136	.177	1 3/4	5/16	1:6
1	2	1 1/8	.136	.177	1 3/4	5/16	1:6
1 1/8	2 1/4	1 1/4	.136	.177	2 1/4	5/16	1:6
1 1/4	2 1/2	1 3/8	.136	.177	2 1/4	5/16	1:6
1 3/8	2 3/4	1 1/2	.136	.177	2 1/4	5/16	1:6
1 1/2	3	1 5/8	.136	.177	2 1/4	5/16	1:6
1 3/4	3 3/8	1 7/8	.178 ^A	.28 ^A	-	-	-
2	3-3/4	2-1/8	.178 ^A	.28 ^A	-	-	-
Over 2 to 4 Incl.	2D-1/2	D+1/8	.24 ^B	.34 ^B	-	-	-

1 A. 3/16" nominal

2 B. 1/4" nominal

3 (F) Galvanized High Strength Bolts, Nuts and Washers

4 Use galvanized high strength bolts, nuts and washers meeting all other requirements of
5 this subarticle except as follows:

6 (1) Use Type 1 bolts.

7 (2) Quench and temper washers.

8 (3) Mechanically galvanize in accordance with ASTM B695, Class 55.

9 (4) Ship galvanized bolts and nuts in the same container.

10 (5) Use organic zinc repair paint for touch-up of galvanized surfaces meeting
11 Article 1080-9.

12 (6) Include in manufacturer's test reports results of the zinc coating thickness
13 measurements.

14 (7) Have each galvanized nut coated with a wax lubricant with a color contrast to that of
15 the zinc coating.

16 1072-6 WELDED STUD SHEAR CONNECTORS

17 Use Type B shear studs in accordance with the Bridge Welding Code as defined in
18 Article 1072-18.

19 Use and install welded stud shear connectors meeting Article 1072-18. Ensure that shear
20 studs and the areas of beams, girders or other structural steel to which the studs are welded are
21 free of rust, rust pits, oil, grease, moisture, paint, galvanizing, loose mill scale or other
22 deleterious matter which adversely affects the welding operation. Apply shear studs on steel
23 with tightly adhering mill scale as determined by the Engineer provided acceptable results are
24 achieved and the installed studs meet the Bridge Welding Code.

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1 1072-7 INSPECTION

2 (A) General

3 Give the Materials and Tests Unit 72 hours notice for in-state producers and 192 hours
4 notice for producers out-of-state before beginning work in the shop. Do not manufacture
5 or fabricate any material, other than stock items, before the Materials and Tests Unit is
6 notified and the final shop drawings are reviewed, accepted and returned to the fabricator.

7 The contractor/fabricator shall be responsible for and shall be required to perform all
8 quality control procedures and nondestructive testing in accordance with the Bridge
9 Welding Code as defined in Article 1072-18 and as required by the contract. Perform all
10 quality control procedures and nondestructive testing in the presence of the Department's
11 inspector unless otherwise approved by the Department's inspector. Obtain approval for
12 all quality control inspectors from the Department's inspector and ensure their
13 qualification in accordance with the Bridge Welding Code. Maintain all QC reports as
14 required by the Bridge Welding Code, including, but not limited to, visual and
15 nondestructive testing reports and all phases of coating application inspection. Provide
16 copies of all QC reports, including all radiographic films, to the Department inspector
17 upon request. These copies become the property of the Department. No separate
18 payment is made for this inspection and testing. The entire cost of this work is included
19 in the unit contract price for the structural steel items involved.

20 Furnish facilities for the inspection of material and work in the mill and shop, and allow
21 the inspectors free access to the necessary parts of the mill or shop. Do not ship any
22 member or component of the structural steel from the shop to the job site before approval
23 by the Department's inspector. Such approval is stamped on the member or appropriate
24 container by the Department's inspector.

25 Furnish the Engineer with as many copies of mill orders and shipping statements as
26 directed. The acceptance of any material or finished member by the Department's
27 inspector is not a bar to their subsequent rejection, if found defective. Replace rejected
28 material and correct rejected work promptly and satisfactorily.

29 (B) Shop and Mill Inspection

30 Shop inspection is performed on all structural steel used on any project. Mill inspection
31 of structural steel is performed when so noted in the plans or in the Specifications.
32 Furnish complete certified mill test reports for all structural steel used except
33 a Type 6 material certification in accordance with Article 106-3 as to the grade of steel
34 used is acceptable for small amounts of structural steel items which are furnished from
35 the supplier's stock and which are difficult to identify on any mill test report.

36 Show in the supplier's certification the items fabricated from stock material and the
37 pounds of steel required for each item. A supplier's certification represents only anchor
38 bolts, pipe sleeves, masonry plates, sole plates, diaphragm tees, connector plates and web
39 stiffener plates. Represent all other items required for a structure by certified mill test
40 reports as specified above.

41 Indicate in the complete certified mill test reports the pounds of steel and the item or
42 items they represent and show heat number of steel, mechanical tests, chemical analyses,
43 Department's project number, station number, the ASTM or AASHTO specification to
44 which the material conforms and a signed statement certifying where the steel was melted
45 and manufactured.

46 Forward to the Materials and Tests Unit a letter which states by station the items and
47 pounds of steel that are represented by a supplier's certification and those represented by
48 the certified mill test reports identifying the beam and/or plate material for each main
49 member.

1 The Department reserves the right to select any item for test. Bear any expense of
2 obtaining the sample. The tests are performed at the Department's expense.

3 **(C) Sampling Structural Steel**

4 Furnish samples of structural steel at the beginning of fabrication when random sampling
5 is required.

6 Furnish one 2 1/2" x 24" sample for each grade of steel used on a project per
7 1,000,000 lb. No more than 2 are required per project.

8 Take all samples at the location and in the manner directed by an authorized
9 representative of the Engineer. Furnish the necessary personnel and equipment for
10 obtaining samples and be responsible for providing a smooth finish to the areas from
11 which the samples are taken.

12 **(D) Charpy V-Notch Tests**

13 Furnish all structural steel for girders, beams and diaphragm components connecting
14 horizontally curved members meeting the longitudinal Charpy V-Notch Tests specified in
15 the supplementary requirements in AASHTO M 270 for Zone 1. Unless otherwise noted
16 in the plans, mark and test the materials as non-fracture critical. Sample and test in
17 accordance with AASHTO T 243 and use the (H) frequency of heat testing. Use the
18 grade or grades of structural steel required in the plans. Obtain and submit certified mill
19 test reports to the Materials and Tests Unit to show the results of each test required by the
20 *Standard Specifications*.

21 **1072-8 WORKING DRAWINGS**

22 Submit prints of checked structural steel shop drawings and changes thereto, including
23 shipping diagrams for review, comments, acceptance and distribution as follows:

24 **(A)** Submit 2 sets for review, comments and acceptance on all steel structures. After review,
25 comments and acceptance, submit 7 sets for distribution.

26 **(B)** Submit 5 sets for review, comments and acceptance for all bridges carrying railroad
27 traffic, and after acceptance, submit 9 sets for distribution.

28 **(C)** Furnish any additional sets requested by the Engineer or for his use, review, comments,
29 acceptance and/or distribution.

30 Shop drawings are not checked by the Engineer except to ascertain general compliance with
31 the design and the *Standard Specifications*. Thoroughly check all shop drawings in all
32 respects. Review, comments and acceptance of shop drawings by the Engineer is not
33 considered as relieving the Contractor of his responsibility for the accuracy of his drawings,
34 or for the fit of all shop and field connections and anchors.

35 The maximum size of prints for shop drawings is 22" x 36", including borders which are at
36 least 1" at the left edge of the sheet. Provide shop drawings on any medium provided they are
37 legible and are reproducible. Upon completion of the project, furnish to the Engineer one
38 complete set of reproducible shop drawings that represent the as-built condition of the
39 structural steel including all approved changes if any. Supply drawings that are 22" x 36".
40 These drawings will become the property of the Department.

41 Changes on shop drawings after acceptance or distribution are subject to the approval of the
42 Engineer. Furnish a record of such changes.

43 Make substitution of sections different from those on the structure plans only when approved
44 in writing.

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1 1072-9 HANDLING AND STORING MATERIALS

- 2 Load, transport, unload and store structural material so the metal is kept clean and free from
3 damage. Repair any coating damage. Do not use chains, cables or hooks that damage or scar
4 the material. Repair all materials which are scarred or damaged and inspect at the fabricators
5 expense as deemed necessary by the Engineer.
- 6 Use lifting equipment and rigging equipment with adequate capacity to handle the material at
7 all times. Do not bend, twist, damage or excessively stress any materials. Do not perform
8 hammering which injures or distorts the members. Operate and maintain all lifting equipment
9 in a safe manner and in accordance with the manufacturer's directions.
- 10 When lifting main structural steel members, use spreader bars. Do not use one point pick-ups
11 on members over 50 ft in length. Use 2 point pick-ups so the amount of overhang and the
12 distance between hooks does not exceed the distances as noted in Table 1072-5.

Property	Beam Size			
	30" or Less	33" WF	36" WF	Plate Girders
Maximum Distance Between Hooks	74 lf	80 lf	85 lf	100 lf
Maximum Overhang	25 lf	28 lf	30 lf	35 lf

- 13 Store structural material, either plain or fabricated, above the ground upon platforms, skids or
14 other supports. Keep free from dirt, grease, vegetation and other foreign matter, and protect
15 as far as practicable from corrosion.
- 16 Keep material clean and properly drained. Transport and store girders and beams with the
17 web in the vertical plane and the top flange up. Request permission in writing and await
18 approval to invert haunched girders and beams for transport for safety reasons. Use extreme
19 care in turn-over operations to prevent excessive bending stresses in the edge of flanges.
20 Support long members on blocking placed near enough together to prevent damage from
21 deflection.
- 22 Do not use any beam, girder, diaphragm, cross frame or other material, in any stage of
23 fabrication that will be permanently incorporated into the finished structure as a workbench,
24 lifting device, dunnage or for any purpose for which it was not specifically intended.

25 1072-10 STRAIGHTNESS, CAMBER AND DIMENSIONAL TOLERANCES

26 (A) General

- 27 Ensure that rolled material, before being laid out or fabricated, is straight.
28 If straightening is necessary, use methods that do not damage the metal. Kinks or sharp
29 bends are cause for rejection of the material.
- 30 Ensure that heat straightened or heat cambered parts are substantially free from external
31 forces, except those resulting from mechanical means used in conjunction with the
32 application of heat.
- 33 After heating, allow the metal to cool, without artificial cooling, down to 600°F. Below
34 600°F, only dry compressed air is permitted to artificially cool steels having minimum
35 yield strength greater than 36,000 psi as indicated by a Type 1 material certification in
36 accordance with Article 106-3.

37 (B) Straightening

- 38 Straighten distorted members and bent material by mechanical means or, if approved, by
39 the carefully planned and supervised application of a limited amount of localized heat.
40 Do not allow the temperature of the heated area to exceed 1,200°F as controlled by
41 temperature indicating crayons or other approved methods.

1 Following the straightening of a bend or buckle, free the surface of the metal from
2 evidence of fracture as indicated by visual inspection or, if directed, by appropriate
3 nondestructive testing.

4 Shop straighten the bottom flanges of steel beams or girders at bearings as necessary to
5 provide uniform contact between the flanges and the bearings.

6 **(C) Camber**

7 Show the required camber on the drawings.

8 Make adequate provision in the fabrication of structural members to compensate for
9 change of camber due to welding of the shear connectors and other fabrication work.

10 Fabricate camber into the members on built-up plate girders and trusses. Where camber
11 is required on rolled sections, induce it by heat cambering, except that for rolled sections
12 within the depth, length and camber ordinate range shown in Table 1072-6, induce
13 camber by cold cambering or "gagging" at the mill or in the shop provided approval
14 procedures for cold cambering are employed.

15 Attach cover plates on rolled sections after cambering.

16 Where reverse curvature is required in a single rolled shape, induce it by heat cambering.

17 Show camber diagrams showing the required offset at each tenth point of the span and at
18 any web splice or field splice location and blocking diagrams on the shop drawings.
19 Show additional points if desired by the fabricator. Ensure that the beams, girders or
20 other members with field splices meet all of the blocking ordinates without inducing
21 stress into the members.

22 Following cambering or camber correction, correct evidence of fracture indicated by
23 visual inspection or, if directed, by appropriate nondestructive testing.

24 Show camber and blocking diagrams on the shop drawings. Shop assemble continuous
25 beams meeting all the blocking ordinates without inducing stress into the members.

TABLE 1072-6		
ACCEPTABLE COLD CAMBER FOR ROLLED SECTIONS		
Beam Length, feet	Section Designation and Nominal Depth	
	W-Shapes 14" to 21" Inclusive S-Shapes 12" and Over	W-Shapes 24" and Over
Over 30 through 42	3/4" to 2 1/2" inclusive	1" to 2" inclusive
Over 42 through 52	1" to 3" inclusive	1" to 3" inclusive
Over 52 through 65	2" to 4" inclusive	2" to 4" inclusive
Over 65 through 85	2 1/2" to 5" inclusive	3" to 5" inclusive
Over 85 through 100	As directed by the Engineer	3" to 6" inclusive

26 **(D) Heat Cambering of Rolled Beams and Welded Plate Girders**

27 (1) General

28 Where heat cambering is used, only V-type heating is permitted. Perform V-type
29 heating by the carefully planned and supervised application of a limited amount of
30 localized heat.

31 When minor corrections in camber are required, use small localized heats limited to
32 the flange material. Perform major corrections in camber by V-type heating to
33 prevent web distortion.

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1 Begin heating at the apex of the heating pattern and progress slowly towards the base
2 of the pattern as each area is brought up to temperature as stated in
3 Subarticle 1072-10(D)(5). Do not progress the heating torches toward the base of
4 the heating pattern until the apex of the pattern is brought up to the specified
5 temperature. Do not return the heating torch toward the apex of the heating triangle
6 after heating has progressed towards the base. Continue heating to successive areas
7 until the base of the triangular heating pattern is brought up to the required
8 temperature across the full width of the flange.

9 (2) Heat Cambering of Rolled Beams

10 Heat cambering of rolled beams is allowed to provide the required vertical curvature.
11 Space triangular heating patterns throughout the length of the member to provide the
12 required curvature. Locate the apex of the heating triangle at a point not less
13 than 75% of the depth of the member measured from the flange that is concave after
14 cambering. Limit the total included angle of the heating pattern to 20°.

15 Weld all detail material such as connection plates, bearing stiffeners and gusset
16 plates attached to the member to the rolled beam after the beam is cambered as
17 required.

18 (3) Heat Cambering of Welded Plate Girders

19 Heat cambering of welded plate girders is only permitted when approved in writing
20 as a necessary repair procedure for plate girders rejected for camber deviation.

21 When it is necessary to correct camber deviation in welded plate girders, heating is
22 permitted in V-type heating patterns centered on intermediate stiffeners and
23 connection plates. Where necessary, add stiffeners for this purpose if approved.
24 Locate the apex of the heating pattern not less than 3/4 of the depth of the member
25 from the flange that is shortened after cooling. The maximum included angle of the
26 heating pattern is 10°. The maximum width of the base of the heating pattern is 10".
27 Where shallow members or thin webs prescribe heating patterns with a width
28 substantially less than 10" at the junction of the web to flange, extend the heating
29 pattern in the flange at that location beyond the limits of the heating pattern in the
30 web by no more than 1" provided the total width of pattern in the flange does not
31 exceed the 10" limit stated above.

32 (4) Support of Members for Heat Cambering

33 Heat camber members with the web vertical and supports spaced to take the
34 maximum advantage of dead load in the member before applying heat. Ensure all
35 supports are approved by the Department's inspector before beginning work.

36 Do not place any combination of support system or external load on the member that
37 causes a compressive stress in the flange to exceed 20,000 psi before heating for
38 AASHTO M 270 Grades 36, 50 and 50W steels.

39 (5) Heating Process and Equipment

40 Heat using large, approximately 1" diameter, multi-orifice (rosebud) heating torches
41 operating on approximately 25 psi thermal gas and 125 psi oxygen.

42 The torches and tips used are subject to approval. Choose torches and tips that
43 promote heating efficiency and prevent unnecessary distortion.

44 Confine heating to the patterns described herein and conduct to bring the steel within
45 the planned pattern to a temperature between 1,100°F and 1,200°F as rapidly as
46 possible without overheating the steel.

1 Any heating procedure which causes a portion of the steel to exceed a temperature
2 greater than 1,200°F is destructive heating and is automatically cause for rejection of
3 the steel. Steel rejected for destructive heating is investigated for re-acceptance,
4 repair or replacement if allowed by the Engineer. Bear the cost of such tests and any
5 necessary repair or replacement.

6 (6) Heat Measurement

7 Specified temperatures are checked using portable digital pyrometers.

8 **(E) Heat Curving Girders**

9 (1) Type of Heating

10 With approval, use continuous or V-type heating methods to curve girders. For the
11 continuous method, simultaneously heat a strip along the edge of the top and bottom
12 flanges that is of sufficient width and temperature to obtain the required curvature.
13 For V-type heating, heat the top and bottom flanges simultaneously in truncated
14 triangular or wedge-shaped areas. Position the areas with their base along the flange
15 edge and spaced at regular intervals along each flange. Set the spacing and
16 temperatures to approximate the required curvature by a series of short chords. Heat
17 along the top and bottom flanges at approximately the same rate.

18 For V-type heating, terminate the apex of the truncated triangular area applied to the
19 inside flange surface just before the juncture of the web and flange. To avoid web
20 distortion, make certain that heat is not applied directly to the web when heating the
21 inside flange surfaces (the surfaces that intersect the web). Extend the apex of the
22 truncated triangular heating pattern applied to the outside flange surface to the
23 juncture of the flange and web. Use an included angle of approximately 15° to 30°
24 in the truncated triangular pattern, but do not allow the base of the triangle to
25 exceed 10". Vary the patterns prescribed above only with the Engineer's approval.

26 For both types of heating, heat the flange edges that will be on the inside of the
27 horizontal curve after cooling. Concurrently heat both inside and outside flange
28 surfaces for flange thicknesses of 1.25" and greater. Adhere to the temperature
29 requirements presented below.

30 (2) Temperature

31 Conduct the heat curving operation so the temperature of the steel never exceeds
32 1,150°F as measured by temperature indicating crayons or other suitable means. Do
33 not artificially cool the girder until it naturally cools to 600°F. Below 600°F, use dry
34 compressed air to artificially cool the girder.

35 (3) Position for Heating

36 Heat-curving the girder with the web in either a vertical or horizontal position is
37 permitted. When curved in the vertical position, brace or support the girder so the
38 tendency of the girder to deflect laterally during the heat-curving process does not
39 cause the girder to overturn.

40 When curved in the horizontal position, support the girder near its ends and at
41 intermediate points, if required, to obtain a uniform curvature. Do not allow the
42 bending stress in the flanges to exceed 27,000 psi. To prevent a sudden sag due to
43 plastic flange buckling when the girder is positioned horizontally for heating, place
44 intermediate safety catch blocks at the midlength of the girder within 2" of the
45 flanges at all times during the heating process.

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(4) Sequence of Operations

Conduct the heat-curving operation either before or after completing all the required welding of transverse intermediate stiffeners to the web. However, unless provisions are made for shrinkage, position and attach connection plates and bearing stiffeners after heat-curving. In any event, weld the stiffeners, connection plates, and bearing stiffeners to the girder flanges after the member is curved. If longitudinal stiffeners are required, heat-curve or oxygen-cut these stiffeners separately before welding to the curved girder.

(5) Camber and Curvature

Camber the girders before heat-curving. Cut the web to the prescribed camber allowing for shrinkage due to cutting welding and heat-curving. If approved, a carefully supervised application of heat is permitted to correct moderate deviations from the specified camber.

Horizontal curvature and vertical camber is measured for final acceptance after all welding and heating operations are complete and the flanges have cooled to a uniform temperature. Horizontal curvature is checked with the web in the vertical position by measuring offsets from a string line or wire attached to both flanges or by using other suitable means. Camber is checked with the web in the horizontal position. Camber the girder so it meets the horizontal and vertical curvature ordinates without inducing stress into the girders by mechanical force.

Compensate for loss of camber in the heat-curved girders as residual stresses dissipate during service life of the structure. Compute this anticipated loss of camber in accordance with the *AASHTO LRFD Bridge Design Specifications*.

(6) Procedure Specification and Shop Drawings

Submit structural steel shop drawings, including a detailed written procedure specification for heat curving the girders, supplemented by calculations and sketches, for review, comments and acceptance. On the shop drawings, indicate the type, location and spacing of heat sectors, if used, supports and catch blocking for each field section of girders. Include suitable blocking diagrams for measuring horizontal curvature similar to those usually prepared for camber and vertical curvature.

(F) Camber Measurement

At the time of acceptance at the shop and after erection, ensure that all stringers and girders for bridges meet the required camber values within the tolerances specified in Subarticle 1072-10(G). Follow the procedure for measuring camber as outlined below:

- (1) Assemble the member at the shop as specified in Article 1072-19 and measure with the member lying on its side.
- (2) Camber repairs are only allowed when approved by the Engineer. Camber deviation is judged irreparable if corrective measures in the shop produce web buckling in excess of the specified tolerance, in which case the member is rejected.
- (3) The final camber measurement is made by the Engineer in the field after erection. At the time of this measurement, ensure that the members have all of the specified camber less the dead load deflection of the steel as specified in Subarticle 1072-10(G).

(G) Dimensional Tolerances

Ensure that dimensions of all material covered by Section 1072 conform to **ASTM A6** when received at the fabrication shop. Fabricate member dimensions conforming to this subarticle whether designated to be straight, cambered or curved and regardless of whether curvature is heat-induced (when so permitted). Dimensional tolerances not listed

1 in this subarticle shall be as specified by the Bridge Welding Code as defined in
 2 Article 1072-18 and applied to rolled shapes where applicable as well as to welded
 3 members.

4 Place welded butt joints no further than 1/2" from the point detailed. Intermediate
 5 stiffeners varying $\pm 1/2"$ from the point detailed are allowed. Connector plates for field
 6 connections varying $\pm 1/8"$ from the point detailed are allowed. Ensure that the actual
 7 centerline of bearing lies within the thickness of the bearing stiffener.

8 Members with end milled for bearing and members with faced end connection angles
 9 deviating from the detailed length by $-0, +1/32"$ are acceptable. All other members
 10 varying from detailed length by $\pm 1/8"$ are acceptable.

11 Align to within $\pm 1/8"$ from the location shown on the approved shop drawings all steel
 12 requiring shop assembly for reaming, drilling from the solid or weld joint preparation.

13 Deviation from specified camber of fabricated members before shipment from the
 14 fabrication shop is limited to:

15 $-0;$

16 $\frac{+3/32" \times \text{No. of ft from nearest bearing}}{10}$, up to $3/4"$ maximum.
 17

18 Deviation from specified camber of erected steel bridge superstructures measured when
 19 the steel work is complete and the superstructure is subject to steel dead load stresses only
 20 is limited to:

21 $-0;$

22 $\frac{+1/8" \times \text{No. of ft from nearest bearing}}{10}$, up to $1"$ maximum.
 23

24 If the plans do not require shop induced camber, provide an actual member that is straight
 25 or one of the following:

26 (1) If natural camber "turned up" is required, the maximum plus camber is the algebraic
 27 sum of the allowable deviation, dead load deflection, vertical curve ordinate and
 28 superelevation ordinate;

29 (2) If natural camber "turned down" is required, the maximum negative camber is equal
 30 to the algebraic sum of the dead load deflection, vertical curve ordinate and
 31 superelevation ordinate.

32 Do not exceed $1/8"$ per 10 ft length for the actual deviation from curvature shown in the
 33 plans.

34 **1072-11 OXYGEN CUTTING**

35 Oxygen cutting of structural steel is allowed, provided a smooth surface free from cracks and
 36 notches is secured and an accurate profile is secured by the use of a mechanical guide. Hand
 37 cut only where approved and grind smooth leaving no burnt edges.

38 In all oxygen cutting, adjust and manipulate the cutting agent to avoid cutting beyond (inside)
 39 the prescribed lines. Provide oxygen cut surfaces meeting the ANSI surface roughness rating
 40 value of 1,000 except ensure that oxygen cut surfaces of members not subject to calculated
 41 stress meet the surface roughness value of 2,000. Round corners of oxygen cut surfaces of
 42 members carrying calculated stress to a $1/16"$ radius, or an equivalent flat surface at a suitable
 43 angle, by grinding after oxygen cutting.

44 Fillet re-entrant cuts to a radius of not less than $1"$.

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1 Remove surface roughness exceeding the above values and occasional notches, gouges and
2 cracks not more than 1/16" deep on otherwise satisfactory oxygen cut surfaces by chipping or
3 grinding. Flair corrections of the defects with the surface of the cut on a bevel of one to 6 or
4 flatter.

5 Repair occasional gouges of oxygen cut edges more than 3/16" deep, but not more than
6 7/16" deep, by welding with low hydrogen electrodes not exceeding 5/32" in diameter and
7 with a minimum preheat of 250°F. Grind the completed weld smooth and flush with the
8 adjacent surface. Radiographically test any gouge over 1/8" deep after the repair.

9 **1072-12 EDGE PLANING**

10 Plane sheared edges of plates more than 5/8" in thickness that carry calculated stress to
11 a depth of 1/4". Fillet re-entrant cuts before cutting. Round all edges of plates and shapes
12 parallel to calculated stress and all free edges of plates and shapes intended for coating or
13 galvanizing to 1/16" radius or provide an equivalent flat surface at a suitable angle. Grind
14 edges of all other plates and shapes to remove burrs, slag or shear lip. The ends of all steel
15 piles, intended for coating or galvanizing, are not required to be radiused, but remove all
16 burrs, slag and shear lip.

17 **1072-13 FACING OR BEARING SURFACES**

18 Provide a surface finish of bearing and base plates and other bearing surfaces that come in
19 contact with each other or with concrete that meet Table 1072-7 following ANSI surface
20 roughness requirements as defined in ANSI B46.1.

TABLE 1072-7 SURFACE ROUGHNESS REQUIREMENTS	
Item	ANSI Surface Roughness
Steel slabs	ANSI 2,000
Heavy plates in contact in shoes to be welded	ANSI 1,000
Milled ends of compression members, milled or ground ends of stiffeners and fillers	ANSI 500
Bridge rollers and rockers	ANSI 250
Pins and pin holes	ANSI 125
Sliding bearings	ANSI 125

21 **1072-14 ABUTTING JOINTS**

22 Face and bring to an even bearing abutting joints in compression members, girder flanges and
23 tension members where so indicated on the drawings. Where joints are not faced, do not
24 exceed an opening of 1/4".

25 **1072-15 BENT PLATES**

26 Provide cold-bent, load carrying rolled-steel plates conforming to the following:

- 27 (A) Take from the stock plates so the bendline is at right angles to the direction of rolling.
- 28 (B) Use a radius of bends such that no cracking of the plate occurs. Use minimum bend radii,
29 measured to the concave face of the metal, as shown in Table 1072-8.

30 If a shorter radius is essential, bend the plates hot at a temperature not greater than
31 1,200°F and air cool slowly down to a temperature of 600°F. Below 600°F, use only dry
32 compressed air to artificially cool steels having a minimum yield strength greater than
33 36,000 psi. Use hot bent plates conforming to Subarticle 1072-15(A) above.

- 34 (C) Before bending, round the corners of the plates to a radius of 1/16" throughout the
35 portion of the plate at which bending occurs.

**TABLE 1072-8
MINIMUM BEND RADII**

Plate Thickness (t)	Minimum Bend Radii, Ratio of Thickness
Up to 1/2"	2t
Over 1/2" to 1"	2 1/2t
Over 1" to 1 1/2"	3t
Over 1 1/2" to 2 1/2"	3 1/2t
Over 2 1/2" to 4"	4t

1 Hot bend low alloy steel in thicknesses over 1/2" for small radii, if required.

2 **1072-16 HOLES FOR BOLTS AND OTHER FASTENERS**

3 **(A) General**

4 Punch or drill all holes and remove any burrs. Punching material forming parts of
5 a member composed of not more than 5 thickness of metal 1/16" larger than the nominal
6 diameter of the fastener is allowed whenever the thickness of the material is not greater
7 than 3/4" for structural steel, 5/8" for high-strength steel or 1/2" for quenched and
8 tempered alloy steel, unless subpunching and reaming is required by
9 Subarticle 1072-16(D).

10 When there are more than 5 thicknesses or when any of the main material is thicker than
11 3/4" for structural steel, 5/8" for high-strength steel or 1/2" for quenched and tempered
12 alloy steel, either subdrill and ream or drill all holes full size.

13 When required by Subarticle 1072-16(D), subpunch or subdrill all holes (subdrill if
14 thickness limitation governs) 1/4" smaller and, after assembling, ream 1/16" larger or
15 drill full size to 1/16" larger than the nominal diameter of the fastener.

16 **(B) Punched Holes**

17 Do not use a diameter of the die exceeding the diameter of the punch by more than 1/16".
18 If any holes require enlargement to admit the fasteners, ream such holes. Clean cut holes
19 without torn or ragged edges. Poor matching of holes is cause for rejection. Grind all
20 burrs smooth.

21 **(C) Reamed or Drilled Holes**

22 Make reamed or drilled holes cylindrical and perpendicular to the member complying
23 with the size requirements of Subarticle 1072-16(A). Where practicable, direct reamers
24 by mechanical means. Grind all burrs smooth. Poor matching of holes is cause for
25 rejection. Ream and drill with twist drills. If required, take assembled parts apart for
26 removal of burrs caused by drilling. Assemble connecting parts requiring reamed or
27 drilled holes, securely hold while reaming or drilling and match mark before
28 disassembling.

29 **(D) Subpunching and Reaming of Field Connections**

30 Subpunch or subdrill, if required according to Subarticle 1072-16(A), holes in all field
31 connections and field splices of main members of trusses, arches, continuous beam spans,
32 bents, towers (each face), plate girders, and rigid frames. Subsequently ream while
33 assembled as required by Article 1072-19. Subpunch and ream to a steel template or
34 ream while assembled all holes for floor beam and stringer field end connections. Ream
35 or drill full size field connection holes through a steel template after the template is
36 located with utmost care as to position and angle and firmly bolted in place. Use
37 templates for reaming matching members, or the opposite faces of a single member that
38 are exact duplicates. Accurately locate templates used for connections on like parts of
39 members such that the parts or members are duplicates and require no match-marking.

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1 (E) Accuracy of Punched and Subdrilled Holes

2 Accurately punch or subdrill all holes punched full size, subpunched or subdrilled such
3 that after assembling, and before any reaming is done, a cylindrical pin 1/8" smaller in
4 diameter than the nominal size of the hole enters perpendicular to the face of the member,
5 without drifting, in at least 75% of the contiguous holes in the same plane. If the
6 requirement is not fulfilled, the badly punched pieces are rejected. If any hole does not
7 pass a pin 3/16" smaller in diameter than the nominal size of the hole, this is cause for
8 rejection.

9 (F) Accuracy of Reamed and Drilled Holes

10 When holes are reamed or drilled, ensure that 85% of the holes in any contiguous group,
11 after reaming or drilling, show no offset greater than 1/32" between adjacent thicknesses
12 of metal.

13 Use all steel templates with hardened steel bushings in holes accurately dimensioned
14 from the centerlines of the connection as inscribed on the template. Use the centerlines in
15 locating accurately by the template from the milled or scribed ends of the members.

16 (G) Alternate Methods

17 As an option, make the fastener holes by procedures other than those described in
18 Subarticles 1072-16(A) through 1072-16(F) provided that the requirements for quality
19 and for dimensional accuracy are met. Wherever an alternate method is employed,
20 demonstrate the ability of each alternate method to produce holes and connections
21 consistently meeting all requirements for quality and dimensional accuracy for the type of
22 joint fabricated. When such ability of an alternate method is previously demonstrated on
23 similar work for the Department, continue its use by certifying, on each subsequent
24 project, that the procedure and equipment are the same as the method previously
25 qualified, and that the equipment involved is in good repair and adjustment. Failure of
26 joints to meet the quality and accuracy requirements is cause for rejection. In the case of
27 repeated failures revise and/or requalify the method or discontinue its use.

28 At the time of qualification of an alternate method, submit for approval a written
29 procedure specification describing the procedures and equipment and giving upper and
30 lower value limits and tolerances for all pertinent variables. Accurately reflect the actual
31 procedures, equipment and values used in the qualification tests. In addition to the
32 certification on each subsequent project, the Engineer may request copies of the approved
33 procedure specification.

34 (H) Oversize, Short-Slotted, and Long-Slotted Holes

35 Where shown in the plans or permitted in writing, use oversize, short-slotted and long-
36 slotted holes with high strength bolts 5/8" and larger in diameter. Do not allow the
37 distance between edges of adjacent holes or edges of holes and edges of members to be
38 less than permitted under the AASHTO specification. Oversize, short-slotted and long-
39 slotted holes are defined as follows:

40 (1) Oversize holes are 3/16" larger than bolts 7/8" and less in diameter, 1/4" larger than
41 bolts 1" in diameter, and 5/16" larger than bolts 1 1/8" and greater in diameter.
42 When oversized holes are permitted, they are allowed in any or all plies of friction
43 type connections. Install hardened washers over exposed oversize holes.

44 (2) Short-slotted holes are 1/16" wider than the bolt diameter and have a length that does
45 not exceed the oversize diameter requirements of Subarticle 1072-16(H)(1) by more
46 than 1/16". When short-slotted holes are permitted, they are allowed in any or all
47 plies of friction-type or bearing-type connection. Locate holes without regard to
48 direction of loading in friction-type connections, but orient normal to the direction of
49 the load in bearing-type connections. Install hardened washers over exposed short-
50 slotted holes.

1 (3) Long-slotted holes are 1/16" wider than the bolt diameter and have a length more
2 than allowed in Sub-paragraph 2 but not more than 2 1/2 times the bolt diameter.
3 Structural plate washers or a continuous bar not less than 5/16" in thickness are
4 required to cover long slots that are the outer plies of joints. Ensure that these
5 washers have a size sufficient to completely cover the slot after installation. When
6 long-slotted holes are permitted, they are allowed in only one of the connected parts
7 of either a friction-type or bearing-type connection at an individual faying surface.

8 When used in friction-type connections, locate holes without regard to direction of
9 loading if one-third more bolts are provided than needed to satisfy the allowable unit
10 stresses except as herein restricted.

11 When used in bearing-type connections, orient the long diameter of the slot normal to the
12 direction of loading. No increase in the number of bolts over those necessary for the
13 allowable unit stress is required.

14 (I) Misfits

15 When misfits occur for any reason, enlargement of the holes by reaming is limited to
16 1/16" over the nominal size hole called for unless otherwise permitted in writing.

17 (J) Erection Bolt Holes

18 At field welded connections where erection bolts are used, provide holes 3/16" larger
19 than the nominal erection bolt diameter.

20 1072-17 INSTALLING BOLTS

21 Install high strength bolts in accordance with Article 440-8.

22 1072-18 WELDING

23 (A) Definition

24 The Bridge Welding Code referred to herein is the edition of the
25 ANSI/AWS/AASHTO Bridge Welding Code D 1.5 and any applicable interim that is
26 current on the date of advertisement for the project, and as modified by the *Standard*
27 *Specifications*.

28 (B) General

29 Commercially blast clean all steel used in girders, beams and connecting members to
30 SSPC-SP 6 before welding.

31 Weld all steel in the shop or in the field for bridges, whether permanent or temporary, and
32 perform all other work related to welding including, but not limited to, testing and
33 inspection of welds, preparation of material, oxygen cutting, electrodes, shielding and
34 shear studs, meeting the Bridge Welding Code. Weld other steel items in accordance
35 with AWS Welding Code.

36 Weld only where shown in the plans or where called for in the *Standard Specifications*
37 unless requesting and receiving written approval for additional welding.

38 Show all permanent and all temporary welds on the shop drawings. For groove welds,
39 indicate on the shop drawings the particular detail and process to be employed in
40 production of the work. For prequalified joints, use of the Bridge Welding Code letter
41 classification designation of the joint (B-L2b-S etc.) along with the appropriate symbol
42 satisfies this requirement. Tack welds that become part of a permanent weld are not
43 required on the shop drawings.

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1 Provide fillet welds, including seal welds, at least the minimum size allowed by the
2 Bridge Welding Code for the thickness of material welded or the size called for in the
3 plans, whichever is larger. For exposed, bare, unpainted applications of steel, the basic
4 requirements for weld filler metal with atmospheric corrosion resistance and coloring
5 characteristics similar to that of the base metal are mandatory. The variations from these
6 basic requirements listed in the Bridge Welding Code for single pass welds are not
7 permitted.

8 Use only Department approved electrodes for welding. The Department maintains a list
9 of approved brands of electrodes for which satisfactory reports of tests made within one
10 year are previously submitted. This list is available from the State Materials Engineer.
11 Designate an appropriate storage area for all welding consumables in accordance with the
12 Bridge Welding Code.

13 (C) Qualification of Personnel

14 Ensure that each welder, welding operator and tacker is qualified in accordance with the
15 Bridge Welding Code or other applicable AWS Welding Code as determined by the
16 Engineer. Employ welders that are qualified by the Department. Welders shall be
17 requalified by the Department every 5 years. Contact the Materials and Tests Unit to
18 schedule qualification tests. Permanent in-shop welders employed by a fabricator who
19 passed the appropriate welding tests and whose weldments are radiographically tested
20 with regularly acceptable results are exempt from additional testing when approved by
21 the Engineer. Ensure a representative of the testing agency witness all phases of the
22 qualification tests including preparation of the test plates and placing of welds. As
23 evidence of such qualification, furnish a satisfactory certificate, or a copy thereof, issued
24 by a testing agency which is approved by the Engineer, for each welder, welder operator
25 and tacker employed on the work. Submit certification for each welder, welding operator
26 or tacker, and for each project, stating the name and Social Security number of the
27 welder, welding operator or tacker; the name and title of the person who conducted the
28 examination; the kind of specimens; the position of welds; the AWS electrode
29 classification used; the results of the tests; and the date of the examination. Such
30 certifications are required for all persons performing shop or field welds of any kind on
31 the work, whether permanent or temporary. Ensure each welder provides a picture ID
32 upon request or other form of positive identification as required by the Engineer.

33 (D) Qualification of Welds and Procedures

34 Use welds, except as otherwise provided below, that are prequalified in accordance with
35 the details, limitations and procedures prescribed by the Bridge Welding Code or other
36 AWS Welding Code as determined by the Engineer. Substitute other such prequalified
37 welds for those shown in the plans, subject to the approval of the Engineer.

38 For all prequalified field welds, submit Welding Procedure Specifications (WPS) for each
39 joint configuration for approval at least 30 days before performing any welding. Instead
40 of this, use the WPS provided and preapproved by the Department. These preapproved
41 WPS are available from the Materials and Tests Unit. Use non-prequalified welds only if
42 approved by the Engineer. Submit WPS for all non-prequalified welds to the Engineer
43 for approval. At no cost to the Department, demonstrate their adequacy in accordance
44 with the Bridge Welding Code.

45 Include in procedure specifications, upper and lower value limits of all variables listed for
46 procedure qualification in the Bridge Welding Code for the process or processes used.
47 Written welding procedure specifications are required for prequalified welds also.

48 On all welding, include in the welding procedure continuous visual inspection by
49 welders, welding operator, tackers, welding supervisors and all personnel involved in
50 preparation of the material for welding.

1 Approval by the Engineer of the procedure specifications does not relieve the Contractor
2 of his responsibility to develop a welding procedure that produces weldments meeting the
3 required quality and dimensions.

4 If non-prequalified joints procedures are previously found acceptable to the Engineer on
5 another project, furnish the inspector with a copy of the joint details and procedure
6 specification approved at the time of qualification. Such documentation is required from
7 each fabricator employing a non-prequalified joint or procedure on the work. Failure to
8 produce such documentation results in the fabricator being required to requalify the joint
9 or procedure or to use prequalified joints, procedures, and procedure specifications.

10 On weldments where geometric shape prevents compliance with requirements to weld
11 a particular position, alternate procedures are considered for approval. Previously
12 qualified alternate procedures are considered for approval without further procedure
13 qualification tests. No separate payment is made for developing, demonstrating and
14 documenting for future use such alternate procedures, as such work is incidental to the
15 work of welding.

16 **(E) Requirements for Testing and Inspection**

17 Require the fabricator to make provisions for convenient access to the work for
18 inspection and cooperate with the inspector during the required inspection and testing.

19 Inspect welds in the presence of the Department's inspector unless otherwise approved by
20 the Department's inspector, using visual inspection and the nondestructive tests herein
21 prescribed in addition to the test requirements of the Bridge Welding Code and the
22 contract. Employ quality control inspectors and NDT technicians qualified in accordance
23 with the Bridge Welding Code and preapproved by the Engineer before the start of any
24 fabrication. Supply the appropriate certifications as required by the Bridge Welding
25 Code to the Department's inspector for all inspectors. Individuals assigned to production
26 welding activities or processes and their supervisors are not acceptable for performing
27 quality control testing. Ensure a qualified welding inspector presents any time welding is
28 in progress. No separate payment is made for inspection and testing. The entire cost of
29 this work is included in the unit contract price for the structural steel items involved.

30 Retest welds requiring repairs or replacement in the presence of the Department's
31 inspector after the repairs or replacements are made.

32 If the Engineer finds that acceptable repair to defective work is not feasible; the entire
33 piece is rejected.

34 Payment at the contract prices for the various items in the contract which include the
35 work of welding is full compensation for all costs resulting from the required
36 nondestructive testing of welds and from the required inspection of welds.

37 **(F) Nondestructive Test Required**

38 The extent of nondestructive testing required is as prescribed in the Bridge Welding Code
39 and by the contract except radiograph all flange splices for their full length. The term
40 "main members" in this regard means girders, beams, floor beams, stringers, truss
41 members, high strength bolts, columns, bearing stiffeners, bearing shoes, high mount
42 lighting standards and components of main member carrying stress, including the end
43 connections for such members. Nondestructive testing of other complete welds or weld
44 passes is required when so noted in the plans or deemed necessary by the Engineer. Tests
45 other than those prescribed are also required when deemed necessary by the Engineer.
46 Perform all radiographic testing in accordance with procedures established by the
47 Engineer. Copies of these procedures are available from the State Materials Engineer.

48 Use edge blocks when radiographing butt welds greater than 1/2" in thickness. Use edge
49 blocks with a length sufficient to extend beyond each side of the weld centerline for
50 a minimum distance equal to the weld thickness, but not less than 2" and with a thickness

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1 equal to or greater than the thickness of the weld. Use edge blocks with a minimum
2 width equal to half the weld thickness, but not less than 1". Center the edge blocks on the
3 weld with a snug fit against the plate being radiographed allowing no more than
4 1/16" gap. Produce edge blocks from radiographically clean steel and provide a surface
5 finish of ANSI 125 or smoother.

6 High mount lighting standards longitudinal groove welds and fillet welds are
7 radiographically tested as specified by the contract. Other nondestructive test methods
8 are sometimes deemed necessary by the Engineer to determine the quality of the welds.
9 No separate payment is made for inspection and testing. The entire cost of this work is
10 included in the unit contract price involved.

11 (G) Welded Structural Shapes

12 Produce butt welds of flanges and webs, and fillet welds of web to flanges of plate
13 girders and haunched beams using the submerged arc process. Produce other structural
14 shapes built up from plates and bars using the submerged arc process unless another
15 process is qualified for these joints in accordance with the Bridge Welding Code and is
16 subject to the approval of the Engineer.

17 After all shop welded splices in the flanges and webs for the full length of the field
18 section are made, tested and approved, fit the flange plates tight and square against the
19 web to leave no gap and to not bow the web. Brace one side of each flange against the
20 web with gussets or struts and tack weld securely to the web at the stiffener locations.
21 Upon removal of the welds, grind any nicks or gouges, preheat, weld and test or
22 incorporate into the stiffener fillet weld.

23 Connect the flanges to the web by starting the fillet weld at one end of the girder and
24 proceeding to the other ends.

25 As an option, make adjacent welds simultaneously.

26 The sequence for making the flange to web fillet welds is subject only to the provisions
27 for control of shrinkage and distortion and to the position requirements of the Bridge
28 Welding Code.

29 After flange to web welds are complete, shift bracing gussets or struts if necessary, then
30 remove all temporary gussets or struts. Remove tack welds by grinding flush with parent
31 metal.

32 Straighten any transverse warpage of the flanges if necessary by heating along the
33 centerline of the outside face.

34 Fit tight, square and tack weld stiffeners securely to the web. With the girder in the flat
35 position (web horizontal), weld the stiffeners to the web. Do not weld or tack weld
36 stiffeners to the flanges except where noted in the plans.

37 After all parts are welded into place, trim the girder to detail length with adjustments for
38 slope and end rotation exceeding 1/4" net.

39 1072-19 SHOP ASSEMBLING

40 (A) General

41 Assemble the field connections of main members of continuous beam spans, plate girders
42 and rigid frames in the shop with milled ends of compressing members in full bearing,
43 and then ream their sub-size holes to specified size while the connections are assembled.
44 Assembly shall be either Full Girder Assembly or Progressive Girder Assembly unless
45 Full Girder Assembly or Special Complete Structure Assembly is required by the
46 contract.

1 Furnish a camber diagram to the Engineer showing the camber at each panel point of
 2 each continuous beam line, plate girder or rigid frame. When the shop assembly is Full
 3 Girder Assembly or Special Complete Structure Assembly, ensure the camber diagram
 4 shows the camber measured in assembly. When any of the other methods of shop
 5 assembly is used, show the calculated camber in the camber design.

6 Clean surfaces of metal in contact before assembling. Assemble the parts of a member,
 7 pin well and firmly draw together with bolts before reaming. Take assembled pieces
 8 apart, if necessary, for removal of burrs and shavings produced by the reaming operation.
 9 Ensure that the member is free from twists, bends and other deformation.

10 Drift during assembling only to bring the parts into position, and not sufficient to enlarge
 11 the holes or distort the metal. If any holes are enlarged to admit the fasteners, ream them.

12 Match-mark those connecting parts assembled in the shop for the purpose of reaming
 13 holes in field connections and provide a diagram showing marks furnished by the
 14 Engineer.

15 **(B) Full Girder Assembly**

16 Full Girder Assembly consists of assembling all members of each continuous beam line,
 17 plate girder or rigid frame at one time.

18 **(C) Progressive Girder Assembly**

19 Progressive Girder Assembly consists of assembling initially for each continuous beam
 20 line or plate girder at least 2 contiguous shop sections or all members in at least
 21 2 contiguous shop panels but not less than the number of panels associated with
 22 3 contiguous section lengths (i.e., length between field splices) and not less than 150 ft
 23 in the case of structures longer than 150 ft. Add at least one shop section at the advancing
 24 end of the assembly before removing any member from the rearward end, so the
 25 assembled portion of the structure is never less than the specified above.

26 **(D) Special Complete Structure Assembly**

27 Special Complete Structure Assembly consists of assembling the entire structure,
 28 including the floor system.

29 Ensure each assembly, including camber, alignment, accuracy of holes and fit of milled
 30 joints, is approved by the Engineer before reaming.

31 **1072-20 PAINTING AND OTHER PROTECTIVE COATINGS**

32 Shop paint in accordance with Section 442.

33 Repair galvanized surfaces that are abraded or damaged in accordance with Article 1076-7.

34 **1072-21 MARKING AND SHIPPING**

35 Paint or mark each member with an erection mark for identification and furnish an erection
 36 diagram with erection marks shown thereon.

37 Furnish to the Engineer as many copies of material orders, shipping statements and erection
 38 diagrams as the Engineer directs. Show the weights of the individual members on the
 39 statement. Mark the weights on members weighing more than 3 tons. Load structural
 40 members on trucks or cars in such a manner that they are transported, unloaded and stored at
 41 their destination without being excessively stressed, deformed or otherwise damaged.

42 Load and ship steel beams and girders in accordance with the Figures 1072-2 and 1072-3 and
 43 Table 1072-9 for all types of transportation. When the contractor wishes to place members on
 44 trucks not in accordance with these limits, to ship by rail, to attach shipping restraints to the
 45 members, to ship horizontally curved steel members, or to invert members, he shall submit
 46 a shipping plan before shipping. Refer to Article 1072-9.

Section 1072

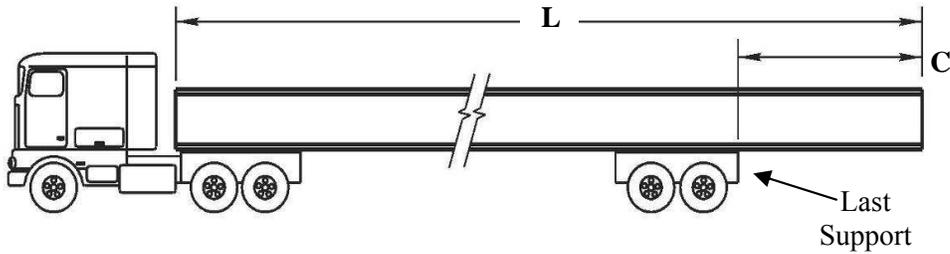
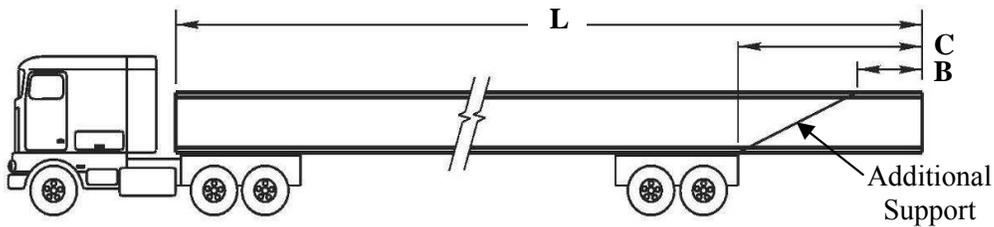


Figure 1072-2. Truck loading diagram for when the length past the last support, *C*, is 15 ft or less.



1

2 **Figure 1072-3.** Truck loading diagram for when the length past the last support, *C*, is
3 between 15 ft and 30 ft.

4 For truck loading with the length of the last support between 15 ft and 30 ft in Figure 1072-3,
5 use the following formulas to calculate truck loading limits or use the values given in
6 Table 1072-9:

7

$$B = 0.4C$$

8

$$C = 0.2L \text{ to } 0.3L, \text{ up to } 30 \text{ ft}$$

9 Where **B** is the length of the member past a required additional restraint, **C** is the length of the
10 member extending past the last support and **L** is the length of the member.

TABLE 1072-9			
LIMITS FOR PLACEMENT OF STEEL BEAMS AND GIRDERS			
DURING SHIPMENT			
Length of Member, feet	Minimum Length Past Last Support, feet	Maximum Length Past Last Support, feet	Maximum Length Past Additional Restraint, feet
<i>(L)</i>	<i>(C)</i>	<i>(C)</i>	<i>(B)</i>
75	15	22.5	9
80	16	24	9.6
85	17	25.5	10.2
90	18	27	10.8
95	19	28.5	11.4
100	20	30	12
105	21	30	12
110	22	30	12
115	23	30	12
120	24	30	12
125	25	30	12
130	26	30	12
135	27	30	12

1 Restrain overhanging ends of beams or girders both vertically and horizontally to prevent
2 excess movement. Chains are permitted to secure beams and girders during shipping only
3 when adequate measures are taken to prevent damage to the material by the use of approved
4 protective material. If necessary, use adequate bracing to prevent bending of the top flange.

5 Pack bolts of one length and diameter and loose nuts or washers of each size separately. Ship
6 pins, small parts and packages of bolts, washers and nuts in boxes, crates, kegs or barrels, but
7 do not allow the gross weight of any package to exceed 300 lb. Plainly mark a list and
8 description of the contained material on the outside of each shipping container.

9 Steel die stamped fabricator's identity, station number, girder number and span number of
10 main members into an unpainted area (if available) near the end of the member. Die stamp
11 members with painted ends outside the painted area but as close to the end as possible.

12 Ship anchor bolts, washers and other anchorage or grillage materials, in time to be
13 incorporated into the masonry portion of the structure.

14 SECTION 1074

15 MISCELLANEOUS METALS AND HARDWARE

16 1074-1 WELDING

17 Certify all welders performing any welding on any metals in accordance with the applicable
18 AWS welding code in the position and process required as approved by the Engineer.

19 1074-2 EXPANSION ANCHORS

20 Unless otherwise shown in the plans, provide expansion anchors consisting of 2 or more units
21 with a minimum of 2 hard metal conical ring wedges and 2 expandable lead sleeves of
22 an equally effective design that is approved by the Engineer. Use anchors providing
23 a minimum safe holding power of 3,000 lb for 3/4" bolts and 2,000 lb for 5/8" bolts, based
24 upon 1/4 of the actual holding power of the anchor in 3,000 psi concrete. Furnish satisfactory
25 evidence, based upon actual tests performed by a commercial testing laboratory, which
26 indicate that the anchors develop the minimum required safe holding power.

27 When it is proposed to use anchors that are previously accepted as meeting the above
28 requirements, the anchors are accepted on the basis of a certified statement indicating the
29 prior acceptance of the furnished anchors.

30 1074-3 PLAIN STEEL BARS WITH THREADED ENDS

31 Provide plain steel bars with threaded ends meeting ASTM A307, Grade A.

32 1074-4 HARDWARE FOR TIMBER STRUCTURES

33 Use machine bolts, drift-bolts and dowels that are either wrought iron or medium steel. Use
34 washers that are cast iron ogee, malleable iron castings or cut from medium steel or wrought
35 iron plate.

36 Use machine bolts with square heads and nuts. Use nails that are cut or round wire of
37 standard form. Use spikes that are cut, wire spikes or boat spikes.

38 Use black or galvanized nails, spikes, bolts, dowels, washers and lag screws for untreated
39 timber.

40 Galvanize or cadmium plate all hardware for treated timber bridges, except malleable iron
41 connectors.

Section 1074

1 1074-5 METAL BRIDGE RAILING

2 (A) General

3 As an option, use either aluminum or galvanized steel metal rail, provided that the same
4 material is used on all structures on the project.

5 Certified mill test reports are required for rails and posts.

6 Place a permanent identifying mark that identifies the fabricator on each post. Use
7 a method and location of the identifying mark such that it does not detract from the
8 appearance of the post.

9 Where it is necessary for rails to be curved, form the curvature in the shop or in the field.
10 Uniformly curve the rail without buckling or kinking. Perform all welding in accordance
11 with AWS D1.1 for steel railing and AWS D1.2 for aluminum railing.

12 Provide an anchor unit of sufficient strength to insure load anchoring capacity as
13 specified for rail loading in the *AASHTO LRFD Bridge Design Specifications*.

14 (B) Aluminum Rail

15 Supply material for posts, post bases, rails, expansion bars and clamp bars meeting
16 ASTM B221 for Alloy 6061 T6.

17 Use material for rivets meeting ASTM B316 for Alloy 6061 T6. Use rivets that are
18 standard button head and cone point cold driven.

19 Use material for nuts meeting ASTM B211 for Alloy 6061 T6.

20 Provide material for washers meeting ASTM B209 for Alloy Alclad 2024 T3.

21 Supply material for shims meeting ASTM B209 for Alloy 6061 T6.

22 Ensure that the handrails meet the dimensional tolerance requirements of ANSI H35.2.

23 (C) Galvanized Steel Rail

24 Use posts, post bases, rails, expansion bars and clamp bars meeting ASTM A36 and
25 galvanize in accordance with ASTM A123. Grind the cut ends of rail smooth and give
26 them 2 coats of organic zinc repair paint. Galvanize the posts and post bases after they
27 are riveted together.

28 Use rivets meeting ASTM A502 for Grade 1 rivets.

29 Use bolts meeting ASTM F593 Alloy 304.

30 Use nuts meeting ASTM F594 Alloy 304.

31 Use washers meeting ASTM F844 except made from Alloy 304 stainless steel.

32 Use materials for shims meeting ASTM A1011 for Grades 36, 40 or 45, or ASTM A1008
33 for Grade C, and galvanized in accordance with ASTM A123.

34 1074-6 STEEL PIPE

35 Steel pipe bent or welded in fabricating shall meet ASTM A53 for standard weight pipe. Use
36 galvanized pipe unless otherwise shown in the plans.

37 1074-7 IRON CASTINGS

38 (A) General

39 Comply with the Department's Iron Casting QA/QC program.

1 Boldly fillet castings at angles, and provide arrises that are sharp and perfect. No sharp,
2 unfilleted angles or corners are permitted. Provide castings that are true to pattern in
3 form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other
4 defects affecting their strength and value for the service intended. Sand blast or
5 otherwise effectively clean of scale and sand all castings to present a smooth, clean, and
6 uniform surface. Welding is not allowed for the purpose of making a casting structurally
7 sound. Welding for cosmetic or other purposes is not allowed without approval of the
8 Engineer.

9 **(B) Gray Iron Castings**

10 Supply gray iron castings meeting AASHTO M 306. Proof load testing will only be
11 required for new casting designs during the design process. Acceptance of production
12 castings will be based on test bars. Cast test bars, of size “B”, attached to and integral
13 with the castings. Instead of this, cast test bars separate from the castings when approved
14 in writing by the Engineer. The Engineer reserves the right to require that a test bar be
15 machined from an actual casting if deemed necessary. Unless otherwise specified, do not
16 coat gray iron castings. Do not perform any welding on castings for any reason without
17 prior approval from the Engineer. Mark castings with the NCDOT Standard Number of
18 the casting design, the fabricator’s ID and the day, month and year of production.

19 **1074-8 STEPS**

20 Fabricate steps for minor drainage structures from deformed reinforcing bars, use gray iron
21 castings meeting Subarticle 1074-7(B) or use composite plastic-steel construction as shown in
22 the plans.

23 The use of steps differing in dimension, configuration or materials from those shown in the
24 plans is allowed by furnishing the Engineer with details of the proposed steps and obtaining
25 written approval for the use of such steps.

26 **1074-9 FABRICATED STEEL GRATES**

27 Use fabricated steel grates made from bars that meet ASTM A36. Galvanize the grates after
28 fabrication in accordance with AASHTO M 111.

29 **1074-10 PINS**

30 Supply pins for bearing assemblies meeting either ASTM A36 or ASTM A108 for
31 Grades 1016 through 1030, unless otherwise required by the plans or specifications.

32 **1074-11 WASHERS**

33 Provide washers for use with fasteners meeting ASTM A436. Provide washers for high
34 strength bolts meeting Article 1072-5.

35 Ensure that the size and finish (plain, weathering or galvanized) of washers is compatible with
36 the fastener.

37 **1074-12 METAL STAY-IN-PLACE FORMS**

38 Provide metal stay-in-place forms for concrete floor slabs of zinc-coated (galvanized) steel
39 sheet conforming to ASTM A653, Structural Steel (SS) Grades 33 through 80 and Coating
40 Class G165 meeting all requirements relevant to steel stay-in-place forms as noted on the
41 contract plans. Do not use material thinner than 20 gauge.

Section 1076

**SECTION 1076
GALVANIZING**

1076-1 GALVANIZING

Wherever galvanizing is required, perform the galvanizing in accordance with this section except where other requirements for galvanizing are included in other sections of the *Standard Specifications*.

Allow the Engineer to obtain samples of molten zinc directly from the galvanizing vat upon request.

1076-2 INSPECTION NOTIFICATION

Coordinate galvanizing inspection with the Materials and Tests Unit in accordance with Subarticle 1072-7(A). Before inspection, the galvanizer/supplier shall provide the Department's inspector with NCDOT approved drawing/purchase order, stating contract number, location of project, quantity/type of material being galvanized and mill test report(s) for respective material.

1076-3 FABRICATED PRODUCTS

Galvanize products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips 1/8" thick and heavier in accordance with AASHTO M 111. Fabricate products into the largest unit that is practicable to galvanize before the galvanizing is done. Fabrication includes all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, welding and riveting. Galvanize components of bolted or riveted assemblies separately before assembly. When it is necessary to straighten any sections after galvanizing, perform such work without damage to the zinc coating.

Completely seal all edges of tightly contacting surfaces by welding and commercial blast clean to SSPC-SP 6 before galvanizing.

Commercial blast clean components with partial surface finishes in accordance with Subarticle 442-7(A) before pickling.

1076-4 HARDWARE

Galvanize iron and steel hardware in accordance with AASHTO M 232.

1076-5 ASSEMBLED PRODUCTS

Completely seal all edges of tightly contacting surfaces by welding before galvanizing. Galvanize assembled steel products in accordance with AASHTO M 111.

1076-6 SHEETS

Galvanize iron or steel sheets in accordance with **ASTM A653**.

1076-7 REPAIR OF GALVANIZING

Repair galvanized surfaces that are abraded or damaged at any time after the application of zinc coating. Surfaces to be repaired shall be clean, dry and free of oil, grease, pre-existing paint, corrosion and rust. Surface to be repaired shall be blast-cleaned to SSPC-SP 10 (near white).

Where circumstances do not allow blast or power tool cleaning to be used, then hand tools may be used. Cleaning shall meet SSPC-SP 2, the removal of loose rust, mil scale or paint to the degree specified, by hand chipping, scrapping, sanding and wire-brushing. Surface preparation shall extend into the undamaged galvanized coating. Spray or brush-apply the paint to the cleaned areas with 2 coats of organic zinc repair paint meeting Article 1080-9. Ensure that the total thickness of the 2 coats is not less than 3 dry mils. Allow adequate curing time before subjecting repaired items to service conditions in accordance with the manufacturer's printed instructions.

1 Application conditions shall be 40°F Air/Steel temperature and rising, steel temperature shall
 2 be 5°F above the dew point and relative humidity shall be 85% or less. Follow paint
 3 manufacturers recommendation if more restrictive than above requirements.

4 Follow paint manufacturers written instructions on storage temperatures, mixing application,
 5 continuous agitation and pot life. No thinners are to be used when applying organic zinc
 6 repair paint by brush or roller.

7 Instead of repairing by painting with organic zinc repair paint, other methods of repairing
 8 galvanized surfaces that are abraded or damaged are allowed provided the proposed method is
 9 acceptable to the Engineer.

10 Excessive damage to galvanized surfaces as determined by the Engineer is cause for rejection.
 11 Replace or re-galvanize rejected galvanized material.

12 SECTION 1077

13 PRECAST CONCRETE UNITS

14 1077-1 GENERAL

15 Use precast concrete units from sources participating in the Department's Precast Concrete
 16 QC/QA Program. A list of participating sources is available from the Materials and Tests
 17 Unit. The Department will remove a manufacturer of precast concrete units from this
 18 program if the monitoring efforts indicated that non-specification material is being provided
 19 or test procedures are not being followed.

20 This section covers the materials for and the production of precast reinforced concrete units
 21 produced in accordance with the contract. Where precast reinforced concrete circular
 22 manhole sections are used, they shall meet AASHTO M 199.

23 1077-2 PLAN REQUIREMENTS

24 The plans for precast units will be furnished by the Department in the *Roadway Standard*
 25 *Drawings* or details shown in the project plans.

26 When the Department does not make precast plans available and the Contractor chooses to
 27 precast, submit drawings to the Engineer for the items proposed to precast. Submit one
 28 complete set of drawings for review, at least 40 calendar days before beginning production.
 29 After acceptance, submit 7 complete sets of drawings. Acceptance by the Engineer of
 30 contractor drawings will not be considered as relieving the Contractor of any responsibility
 31 for precast units. When precast units are load bearing and require structure design, have the
 32 plans prepared and certified by an engineer licensed by the State of North Carolina.
 33 Contractor furnished drawings shall show complete design, installation and construction
 34 information in such detail as to enable the Engineer to determine the adequacy of the
 35 proposed units for the intended use. Contractor drawings shall include details of steel
 36 reinforcement size and placement and a schedule that lists the size and type of precast units at
 37 each location where the precast units are to be used. Produce precast units in accordance with
 38 the approved drawings.

39 1077-3 MATERIALS

40 Refer to Division 10.

Item	Section
Air Entraining Agent	1024-3
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Curing Agents	1026
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6

Section 1077

Item	Section
Miscellaneous Metals	1074
Portland Cement	1024-1
Reinforcing Steel	1070
Silica Fume	1024-7
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Water	1024-4

1 1077-4 INSPECTION

2 The Department reserves the right to place a duly authorized inspector in the plant at any time
3 work related to the production of units for the Department is being performed. Notify the
4 Engineer at least 7 days in advance when such work is scheduled to begin.

5 Provide an office area for the inspector of at least 50 sf with desk, chair, telephone, facilities
6 for proper heating and cooling, adequate lightning and electrical outlets.

7 Acceptance of precast units will be on the basis of tests of materials, compression tests on
8 concrete cylinders and inspection of the finished units, including amount and placement of
9 steel reinforcement, to determine their conformance with the approved dimensions and design
10 and their freedom from defect. The inspector will have the authority to reject any or all units
11 not manufactured in accordance with these specifications. Any unit found to be defective in
12 any manner at any time will be rejected and replaced by an acceptable unit or repaired in a
13 manner approved by the Engineer.

14 (A) Storage

15 Store all Department units in a separate area on the yard. Store all units on a solid,
16 unyielding foundation free of standing water or in a manner directed by the Engineer. Do
17 not stack units before inspection.

18 (B) Transporting

19 Do not transport units away from the casting yard until the concrete has reached the
20 minimum required 28 day compressive strength and a period of at least 5 days elapses
21 after casting, unless otherwise permitted by the Engineer.

22 Do not transport any unit from the plant to the job site before the approval of that unit by
23 the plant inspector. Such approval is stamped on the unit by the plant inspector.

24 1077-5 PORTLAND CEMENT CONCRETE

25 (A) Composition and Design

26 Portland cement concrete is composed of Portland cement, coarse aggregate (#67 or
27 78M), fine aggregate, water and unless otherwise permitted by the Engineer, an air
28 entraining agent. If other cementitious materials and/or chemical admixtures are used,
29 use these materials in the proper proportions to obtain the optimum effect. Do not use
30 calcium chloride or other admixtures containing calcium chloride.

31 Supply concrete that develops a minimum compressive strength as shown in
32 Table 1077-1 unless other strengths are designated on the approved drawings. When
33 required, air entrain concrete to provide an air content of $4.5\% \pm 1.5\%$. Supply concrete
34 with a maximum slump of 3.5" unless a high range water reducer (super plasticizer) is
35 approved by the Engineer. Do not use concrete with a slump exceeding 6". As
36 an option, reduce the cement content of the mix design by up to 20% and replace with fly
37 ash at a rate of 1.2 lb of fly ash for each pound of cement replaced or reduce the cement
38 content up to 50% and replace with blast furnace slag on a pound for pound basis.

TABLE 1077-1 PRECAST CONCRETE STRENGTH REQUIREMENTS AT AN AGE OF 28 DAYS		
Precast Units	Requirement	Specification Reference
<u>BARRIER:</u>		
Portable	4,500 psi	Sect. 854, 1090 and 1170
Permanent	4,500 psi	Sect. 854, 857 and 1090
<u>CULVERTS:</u>		
Circular Pipe	4,000 psi	Sect. 310, 1032, 1034, 1520 and AASHTO M 170
Single Cell Box Sections	5,000 psi	Contract and AASHTO M 259
Pipe Tees	4,000 psi	Sect. 310, 1032 and AASHTO M 170
Pipe Elbows	4,000 psi	Sect. 310, 1032 and AASHTO M 170
Cross & Parallel Special End Sections	3,500 psi	Sect. 310 and 1032
<u>DRAINAGE STRUCTURES:</u>		
Boxes (Solid & Waffle)	4,000 psi	Sect. 840 and ASTM C913
<u>CIRCULAR MANHOLES:</u>		
Base	4,000 psi	Sect. 1525 and AASHTO M 199
Riser Section	4,000 psi	Sect. 1525 and AASHTO M 199
Top Section	4,000 psi	Sect. 1525 and AASHTO M 199
Grade Ring	4,000 psi	Sect. 858 and AASHTO M 199
<u>WALLS AND PANELS:</u>		
Wing, Head & End Walls	4,000 psi	AASHTO T 23
Precast Retaining Wall (PRW) Units	4,000 psi	Contract
Precast Retaining Wall Coping	3,000 psi	Contract
Retaining Wall Panels	4,000 psi	Contract
Sound Barrier Wall Panels	4,500 psi	Contract
<u>INCIDENTAL PRECAST ITEMS:</u>		
Concrete Pads For Outlet Pipe, Controller Base Cabinets	2,500 psi	Sect. 815, 816 and 825
Right-of-Way Markers	2,500 psi	Sect. 806 and 1054
Concrete Anchor For Cable Guardrail	3,000 psi	Sect. 1046
Picnic Tables	2,500 psi	Contract
Waste Containers	2,500 psi	Contract

Section 1077

1 Submit a proposed concrete mix design for the precast units. Determine quantities of fine
2 and coarse aggregates necessary to provide concrete in accordance with this section by
3 the method described in ACI 211 using the absolute volume method.

4 The Engineer will review the mix design only to ascertain general compliance with the
5 *Standard Specifications*. Do not use a mix until notified that the mix is acceptable.
6 Acceptance of the mix design does not relieve the Contractor of his responsibility to
7 furnish an end product meeting the *Standard Specifications*. Upon request from the
8 Contractor, a precast concrete unit mix design accepted and used satisfactorily on any
9 Department project may be accepted for use on other projects.

10 (B) Testing

11 Make all representative concrete test cylinders and all testing required herein in the
12 presence of the plant inspector for items with strength requirements greater than 2,500 psi
13 in Table 1077-1, unless otherwise approved by the Engineer. For items with strength
14 requirements of 2,500 psi, furnish a Type 3 material certification in accordance with
15 Article 106-3 certifying that the item meets this Specification.

16 Before the first load is placed, determine the air content by a calibrated Chace indicator in
17 accordance with AASHTO T 199. If the air content as determined by the Chace indicator
18 fails to meet the *Standard Specifications*, perform 2 more tests with the Chace indicator
19 on the same load and average all 3 tests. Acceptance or rejection of the load is based on
20 the average of the 3 Chace indicator tests. As an alternate method determine the air
21 content by AASHTO T 152, T196 or T121.

22 Perform temperature, air and slump tests whenever cylinders are cast.

23 Determine slump in accordance with AASHTO T 119 with no more than 3 1/2" allowed.

24 For the purpose of testing for the required 28 day compressive strength, furnish, at no
25 cost to the Department, at least 4 concrete cylinders for each class of concrete, each
26 structure and each day that precast units are produced for the Department. If the
27 contractor anticipates an early break request, furnish the Department with 2 concrete
28 cylinders for each early break request. These cylinders are in addition to the 4 concrete
29 cylinders required for each day of production. Make and cure cylinders in accordance
30 with AASHTO T 23 unless, by permission of the Engineer, the units are cured by one of
31 the methods in Article 1077-9 for the full time required to meet the specified compressive
32 strength requirements. In such case, cure the cylinders with the members and in the same
33 manner as the members. Test cylinders in accordance with AASHTO T 22. If the
34 average of 2 cylinders tested to determine compressive strength at the age of 28 days fails
35 to indicate a compressive strength as shown in Table 1077-1, or such compressive
36 strength as is required by the approved drawings, such failure is cause for the rejection of
37 the members represented.

38 (C) Temperature Requirements

39 Maintain the concrete temperature at the time of placing in the forms not less than 50°F
40 nor more than 95°F unless otherwise directed by the Engineer.

41 Place concrete in cold weather in accordance with Article 420-7.

42 (D) Use of Water Reducing Admixtures

43 Use water reducing admixtures in accordance with Subarticle 1000-4(G). Use high range
44 water reducers (super plasticizers), if approved by the Engineer.

1 **1077-6 FORMS**

2 Use forms of sturdy construction and which are capable of consistently providing straight
 3 lines and uniform dimensions in the finished product. Use metal forms except where other
 4 materials are approved by the Engineer. Provide an identifying number on each form, and
 5 mark each precast unit with the same identifying number as the form used to cast unit. Forms
 6 not meeting these requirements are subject to rejection by the Engineer. Provide joints in
 7 forms that are smooth and tight enough to prevent leakage of mortar. Provide inside surfaces
 8 of forms that are accessible for cleaning. After each use, clean the forms thoroughly. Before
 9 casting, free the inside surfaces of the forms from rust, grease or other foreign matter. Do not
 10 allow coatings used for release of members to build up and in no case allow liquid or powder
 11 from coating materials to come in contact with the reinforcement steel.

12 **1077-7 REINFORCEMENT**13 **(A) Steel Reinforcement**

14 Furnish steel reinforcement and place as shown in the plans and in accordance with
 15 Section 1070.

16 **(B) Macro Synthetic Fiber Reinforcement**

17 Substitute as an option, macro-synthetic fibers instead of 4" x 4" W1.4 x W1.4 welded
 18 wire reinforcement for selected precast concrete products in accordance with the
 19 following requirements.

20 (1) Materials

21 Refer to Division 10.

Item	Section
Portland Cement Concrete	1077-5

22 Substitute macro-synthetic fibers only for steel reinforcement with an area of steel of
 23 0.12 sq.in./ft or less in the following items:

24 (a) Precast drainage structure units in accordance with *Roadway Standard*
 25 *Drawings* No. 840.45.

26 (b) Precast manhole 4.0 ft riser sections in accordance with *Roadway Standard*
 27 *Drawings* No. 840.52.

28 All other requirements, including reinforcement for these precast concrete items will
 29 remain the same.

30 (2) Submittal

31 Submit to the Department for approval by the precast producer and fiber
 32 manufacturer, independently performed test results certifying the macro-synthetic
 33 fibers and the precast concrete products meet the requirements listed herein.

34 (3) Macro-Synthetic Fibers

35 Manufacture from virgin polyolefins (polypropylene and polyethylene) and comply
 36 with **ASTM D7508**. Fibers manufactured from materials other than polyolefins.
 37 Submit test results certifying resistance to long-term deterioration when in contact
 38 with the moisture and alkalis present in cement paste and/or the substances present
 39 in air-entraining and chemical admixtures.

40 Fiber length shall be no less than 1.5". Use macro-synthetic fibers with an aspect
 41 ratio (length divided by the equivalent diameter of the fiber) between 45 and 150,
 42 a minimum tensile strength of 40 ksi when tested in accordance with **ASTM D3822**
 43 and a minimum modulus of elasticity of 400 ksi when tested in accordance with
 44 **ASTM D3822**.

Section 1077

(4) Fiber Reinforced Concrete

Approved structural fibers may be used as a replacement of steel reinforcement in allowable structures of *Roadway Standard Drawings* Nos. 840.45 and 840.52. The dosage rate, in pounds of fibers per cubic yard, shall be as recommended by the fiber manufacturer to provide a minimum average residual strength of concrete, tested in accordance with ASTM C1399, of no less than that of the concrete with the steel reinforcement that is being replaced and no less than 5 lb/cy. Submit the recommendations of the manufacturer that correlate the toughness of steel-reinforced concrete with that of the recommended dosage rate for the fiber-reinforced concrete.

Use fiber reinforced concrete with a $4.5\% \pm 1.5\%$ air content and a compressive strength of at least 4,000 psi in 28 days.

Determine workability of the concrete mix in accordance with ASTM C995. The flow time shall at least 7 seconds and no greater than 25 seconds.

Assure the fibers are well dispersed and prevent fiber balling during production. After introduction of all other ingredients, add the plastic concrete and mix the plastic concrete for at least 4 minutes or for 50 revolutions at standard mixing speed.

1077-8 PLACING CONCRETE

Use the procedures and equipment for handling, placing and consolidating the concrete such that a uniformly dense and high grade concrete is obtained in all parts of the unit under all working and weather conditions. Do not mix, handle, deliver, place or finish concrete using devices made of aluminum or containing aluminum.

Internal, external or a combination of internal and external vibration is required as necessary to produce uniformly dense concrete without honeycomb.

1077-9 CURING CONCRETE

(A) General

Precast units are subjected to one of the methods of curing described below or to other methods or combinations of methods approved by the Engineer. Cure the precast units for a sufficient length of time so the concrete develops the specified compressive strength at 28 days or less. Do not strip forms until at least 24 hours after the concrete attains initial set. For this purpose, initial set is defined as at least 500 psi resistance to a standard penetrometer. The option to strip forms earlier is available provided concrete cylinders indicate a strength of at least 75% of the 28 day compressive strength is attained before release for each day's production. Do not deface or injure the units.

(B) Curing at Elevated Temperatures

Cure at elevated temperatures in accordance with Subarticle 1078-10(B).

(C) Water Curing

Water curing of precast units is allowed as described in Subarticle 420-15(B), by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hoses or by any other method that keeps the units moist during the specified curing period. Do not use methods that deface or injure the precast units.

(D) Curing Compound

Application of a curing compound is allowed provided it is left intact until the specified compressive strength is met. Keep all surfaces moist before the application of the compound and damp when the compound is applied. Seal the surface with a single uniform coating at the rate of coverage recommended by the curing compound manufacturer, or as directed by the Engineer, but not less than 1 gallon per 150 sf of area.

1 1077-10 LIFT HOLES, HANDLING

2 Do not cast or drill more than 4 holes in each unit for the purpose of handling or placing
3 unless otherwise approved by the Engineer. Locate all lift holes and handling devices in
4 accordance with plan and design requirements. Units damaged while being handled or
5 transported are rejected or require repair in a manner approved by the Engineer.

6 1077-11 FINAL FINISH

7 Unless otherwise required by the contract, finish all concrete in accordance with
8 Subarticle 420-17(B).

9 Do not repair units with honeycomb, cracks, or spalls until inspected by the Engineer. Use
10 repair methods that are approved by the Engineer before their use. Any appreciable
11 impairment of structural adequacy is cause for rejection.

12 1077-12 EXPOSED AGGREGATE FINISH FOR PRECAST CONCRETE PANELS

13 When required, provide an exposed aggregate finish for front faces of panels with a depth of
14 exposure ranging from 0 to 1/4". Before beginning production, furnish three 12" x 12"
15 sample panels to establish acceptable variations in color, texture and uniformity of the finish.
16 After the sample panels are accepted and within 30 days of beginning production, produce a
17 reinforced test panel of the largest size that will be used for the project with the accepted
18 exposed aggregate finish. Acceptance of the appearance of panels during production will be
19 based on the test panel and accepted sample panels.

20 Use aggregate and cement from the same source as was used for the test panel and accepted
21 sample panels to produce panels with an exposed aggregate finish. Provide access to visually
22 inspect the entire finish of each completed panel and compare it to the test panel appearance
23 before stacking panels. Replace the test panel with a new test panel every 3 months during
24 production or when fly ash or cement source changes.

25 1077-13 STEPS FOR PRECAST DRAINAGE STRUCTURES

26 Supply steps meeting AASHTO M 199 for design, materials and dimensions. Incorporate
27 steps in all drainage structures over 3.5 ft in height. Do not detail the lowest step more than
28 16" from the bottom.

29 1077-14 MARKING

30 Clearly show the following information on each precast member:

31 (A) Date of manufacture,

32 (B) Name of the manufacturer,

33 (C) Piece mark designations where such designations are shown in the plans, and

34 (D) For precast culverts, match mark each precast member by a method approved by the
35 Engineer, before shipment.

36 Indent marking into the concrete or paint on with waterproof paint.

37 1077-15 DIMENSIONS

38 Ensure that all dimensions allow assembly of the units in place without objectionable
39 deviation from the lines shown in the plans. If requested by the Engineer, assemble the
40 precast members to ensure a quality fit before shipment of the precast members.

41 1077-16 INCIDENTAL PRECAST ITEMS

42 Furnish a Type 3 materials certification in accordance with Article 106-3 for incidental
43 precast items in Table 1077-1. Signal Cabinet Foundations shall meet the requirements herein
44 and in Section 1098.

Section 1078

**SECTION 1078
PRESTRESSED CONCRETE MEMBERS**

1078-1 GENERAL

This section covers the materials for and the production of precast, prestressed concrete members produced in accordance with the contract.

Use prestressing of the pretensioning type in which steel prestressing strands are initially stressed and anchored; the concrete is then placed, vibrated and cured; and when the concrete reaches the required strength, the load is transferred from the anchorages to the concrete.

The intent of this section is to require the producer to provide prestressed concrete members that meet the *Standard Specifications* and exhibit characteristics that are not objectionable to the Department.

(A) Producer Qualification

Producers of precast, prestressed concrete members are required to establish proof of their competency and responsibility in accordance with the Precast/Prestressed Concrete Institute's (PCI) Plant Certification Program to perform work for the project. Certification of the manufacturing plant under the PCI program and submission of proof of certification to the State Materials Engineer is required before beginning fabrication. Maintain certification at all times while work is being performed for the Department. Submit proof of certification following each PCI audit to the State Materials Engineer for continued qualification. These same requirements apply to producers subcontracting work from the producer directly employed by the Contractor.

Employ producers PCI certified in Product Group B, Bridge Products and in one of the appropriate categories as listed below:

- (1) B2 Prestressed Miscellaneous Bridge Products includes solid piles, sheet piles and bent caps;
- (2) B3 Prestressed Straight-Strand Bridge Members includes all box beams, cored slabs, straight-strand girders and bulb-tees, bridge deck panels, hollow piles, prestressed culverts and straight strand segmental components; or
- (3) B4 Prestressed Deflected-Strand Bridge Members includes deflected strand girders and bulb-tees, haunched girders, deflected strand segmental superstructure components and other post-tensioned elements.

Categories for elements not listed above will be as required by the project special provision or plans.

(B) Working Drawing Submittals

Before casting girders, submit complete working drawings to the Engineer for approval. The drawings shall detail the exact location and description of all casting holes, attachments and inserts cast in the member for both temporary and permanent applications. The casting holes, attachments and inserts are in association with, but not limited to: fall protection, overhang falsework, metal stay-in-place forms, solar platforms, temporary girder bracing, transit, erection, lifting and handling. If the plan notes indicate that the structure contains the necessary corrosion protection required for a corrosive site, epoxy coat, galvanize or metalize all metallic components except stainless steel and malleable iron components. Electroplating will not be allowed.

1078-2 MATERIALS

Refer to Division 10.

Item
Air Entraining Agent

Section
1024-3

Item	Section
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Epoxy Protective Coating	1081-1
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Miscellaneous Metals	1074
Portland Cement	1024-1
Prestressing Strand	1070-5
Reinforcing Steel	1070
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Silica Fume	1024-7
Structural Steel	1072
Water	1024-4

1 Do not make changes in the source of aggregates, cements or admixtures during the casting of
 2 members in any one span or substructure unit unless approved by the Engineer.

3 **1078-3 INSPECTION**

4 The Department reserves the right to place a duly authorized inspector in the plant at any or
 5 all times work related to the production of members for the Department is performed. Notify
 6 the Engineer at least 7 days in advance when such work is scheduled. Provide an office area
 7 with an approximate floor space of 100 sf, a desk or drafting table, 2 chairs, telephone,
 8 separate dial-up or faster internet access, facilities for proper heating and cooling and
 9 adequate lighting at the plant for the exclusive use of the inspector. The inspector has the
 10 authority to reject any or all members not manufactured in accordance with these *Standard*
 11 *Specifications*. Approval of any member by the inspector at the plant is in no way final, and
 12 further inspection is made at the structure site both before and after the member is placed in
 13 the final position. Any member found to be defective in any manner at any time is rejected
 14 and requires replacement by an acceptable member or repair in a manner approved by the
 15 Engineer.

16 Do not transport any member from the plant to the job site before approval of that member by
 17 the plant inspector. Provide access to all surfaces of the member so the plant inspector has the
 18 opportunity to properly inspect the member before approval. This approval is stamped on the
 19 member by the plant inspector.

20 **1078-4 PORTLAND CEMENT CONCRETE**

21 **(A) Composition and Design**

22 Supply Portland cement concrete composed of Portland cement, coarse aggregate, fine
 23 aggregate, water and an approved air-entraining agent. Add other cementitious materials
 24 and/or chemical admixtures if approved by the Engineer. When admixtures are used, use
 25 them in the proper proportions to obtain the optimum effect. Do not use set accelerating
 26 admixtures, calcium chloride or admixtures containing calcium chloride. If approved,
 27 high range water reducer may be used at a rate not to exceed the manufacturer's
 28 recommended dosage.

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- 1 Supply concrete with a minimum compressive strength of 5,000 psi at the age of 28 days,
- 2 unless otherwise required by the plans or Specifications. Ensure that all coarse aggregate
- 3 used in prestressed concrete passes a 1" sieve. Maintain a cement content of at least
- 4 564 lb/cy but no more than 752 lb/cy. As an option, reduce the cement content of the mix
- 5 design and replace with fly ash or ground granulated blast furnace slag in accordance
- 6 with Article 1024-1. For concrete with a 28 day design strength greater than 6,000 psi, if
- 7 approved, substitute microsilica for cement, in conformance with Article 1024-1.
- 8 Supply concrete meeting Table 1078-1, unless otherwise approved by the Engineer.

TABLE 1078-1 REQUIREMENTS FOR CONCRETE		
Property	28 Day Design Compressive Strength 6,000 psi or less	28 Day Design Compressive Strength greater than 6,000 psi
Maximum Water/Cementitious Material Ratio	0.45	0.40
Maximum Slump without HRWR	3.5"	3.5"
Maximum Slump with HRWR	7"	7"
Air Content (upon discharge into forms)	5 + 2%	5 + 2%

9 Submit to the Engineer proposed concrete mix designs for each strength of concrete used
 10 in the work. Determine quantities of fine and coarse aggregates necessary to provide
 11 concrete in accordance with the *Standard Specifications* by the method described in
 12 ACI 211 using the absolute volume basis.

13 Submit mix designs, stated in terms of saturated surface dry weights, on
 14 M&T Form 312U at least 35 days before using the proposed mix. Adjust batch
 15 proportions to compensate for surface moisture contained in the aggregates at the time of
 16 batching. Changes in the saturated dry mix proportions are not permitted unless revised
 17 mix designs are submitted to the Engineer and are determined to be acceptable for use.

18 Provide with M&T Form 312U a listing of laboratory test results of aggregate gradation,
 19 air content, slump and compressive strength. List the compressive strength of at least
 20 three 6" x 12" or 4" x 8" cylinders. Show the age of the cylinders at the time of testing
 21 and a detailed description of the curing procedure. Perform laboratory tests in
 22 accordance with the following test procedures:

Property	Test Method
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump	AASHTO T 119
Compressive Strength	AASHTO T 23 and T 22

23 If the design 28 day compressive strength is greater than 6,000 psi, submit the
 24 compressive strength of at least 6 cylinders. Ensure that the average strength of the
 25 6 cylinders is at least 1,500 psi above the minimum 28 day compressive strength required
 26 by the plans.

27 When the combination of materials is such that the required strength and/or a workable
 28 slump is not obtained at the minimum specified cement content with the maximum
 29 allowable water-cement ratio, increase the cement content at no cost to the Department
 30 by whatever amount is required to produce the required strength and/or slump without
 31 exceeding the allowable water-cement ratio.

1 The Engineer reviews the mix design only to ascertain general compliance with the
2 *Standard Specifications*. The Engineer notifies the Contractor, in writing, that the mix
3 design is either acceptable or unacceptable. Do not use a mix until notified by the
4 Engineer that the mix design is acceptable. Acceptance of the mix design does not
5 relieve the Contractor of responsibility to furnish an end product meeting specification
6 requirements. Upon request, a mix design accepted and used satisfactorily on any
7 Department project may be accepted for use on other projects.

8 **(B) Testing**

9 Employ a certified concrete technician to perform all testing required by this subarticle at
10 the bed site in the presence of the plant inspector unless otherwise approved.
11 Certification of technicians is awarded upon satisfactory completion of examinations
12 prepared and administered by the Department or other approved agency.

13 (1) Air Content

14 Before allowing placement of the first load in a bed, determine the air content by
15 a calibrated Chace indicator in accordance with AASHTO T 199. During the
16 placement of the first load, determine the air content by AASHTO T 152, T 196 or
17 T 121. Determine the air content in each subsequent 10 cy by the Chace indicator in
18 accordance with AASHTO T 199 before allowing placement. Determine the air
19 content by AASHTO T 152, T 196 or T 121 from all loads from which cylinders are
20 made. If the air content as determined by the Chace indicator, AASHTO T 199, fails
21 to meet the specification requirements, a second test is run on material from the same
22 load and the results of the 2 tests averaged. If the average does not meet the
23 *Standard Specifications*, a test on the same load is conducted using AASHTO T 152,
24 T 196 or T 121. Acceptance or rejection of the load is based on the results of this
25 test.

26 (2) Slump

27 Determine slump in accordance with AASHTO T 119.

28 (3) Strength

29 For the purpose of testing for the required 28 day compressive strength and also for
30 the required compressive strength for the transfer of load, furnish, at no cost to the
31 Department, cylinders made from a sample of concrete placed near the live end of
32 the bed and additional cylinders made from a sample of concrete placed near the
33 dead end of the bed. Make cylinders in accordance with AASHTO T 23, except cure
34 the cylinders in the same manner as the members represented until the strands are
35 released. Place cylinders in clusters at random points along the casting bed. After
36 the strands are released, air cure the cylinders in an approved common area near the
37 testing apparatus for the remainder of the 28 day curing period. Test the cylinders in
38 accordance with AASHTO T 22. Provide approved apparatus for testing the transfer
39 strength of the cylinders. Maintain this apparatus to within 1.0% accuracy and
40 calibrate at intervals not to exceed 12 months by an approved testing company at no
41 cost to the Department. The Engineer reserves the right to require verification
42 immediately after a testing machine is relocated and whenever there is reason to
43 doubt the accuracy of the indicated load, regardless of the time interval since the last
44 verification.

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1 The testing requirements vary according to the 28 day compressive strength required
2 by the plans as follows:

3 (a) Compressive Strength (28 day) of 6,000 psi or Less

4 Test 2 cylinders, one from each end of the bed, for the purpose of determining
5 whether the concrete has reached the required strength for transfer of load.
6 Ensure that the average of the strength tests on the 2 cylinders meets or exceeds
7 the required strength and the lowest cylinder is not more than 200 psi below the
8 required strength.

9 Test 2 cylinders to determine compressive strength at the age of 28 days. The
10 strength from these 2 cylinders is averaged. Ensure that this average is at least
11 5,000 psi or such 28 day compressive strength required by the plans or *Standard*
12 *Specifications*. Ensure that no cylinder indicates a compressive strength less
13 than 400 psi below the required 28 day compressive strength. Failure to meet
14 the above requirements is cause for rejection of the members represented.

15 (b) Compressive Strength (28 day) of Greater Than 6,000 psi

16 Test 4 cylinders, 2 from each end of the bed, for the purpose of determining
17 whether the concrete has reached the required strength for transfer of load. The
18 strengths from the dead end cylinders are averaged and the strengths from the
19 live end cylinders are averaged. Ensure that both of these averages meet or
20 exceed the required release strength and the lowest cylinder is not more
21 than 200 psi below the required strength.

22 Test 3 cylinders from each end to determine the 28 day compressive strength.
23 The strengths from the dead end cylinders are averaged and the strengths from
24 the live end cylinders are averaged. Ensure that both of these averages meet or
25 exceed the 28 day compressive strength. Ensure that no cylinder indicates
26 a compressive strength less than 400 psi less than the required 28 day
27 compressive strength. Failure to meet the above requirements is cause for
28 rejection of the members represented.

29 **(C) Temperature Requirements**

30 Maintain a concrete temperature at the time of placing in the forms between 50°F
31 and 95°F.

32 Do not place concrete when the air temperature, measured at the location of the
33 concreting operation in the shade away from artificial heat, is below 35°F.

34 **(D) Elapsed Time for Placing Concrete**

35 Ensure that the elapsed time for placing concrete is in accordance with
36 Subarticle 1000-4(E). The requirements of Subarticle 1000-4(E) pertaining to
37 Class AA concrete apply to prestressed concrete.

38 **(E) Use of Set Retarding Admixtures**

39 By permission of the Engineer, use an approved set retarding admixture if choosing to
40 take advantage of the extended time interval between adding mixing water and placing
41 the concrete.

42 Use a quantity of set retarding admixture per 100 lb of cement within the range
43 recommended on the current list of approved set retarding admixtures issued by the
44 Materials and Tests Unit.

45 **(F) Use of Water Reducing Admixtures**

46 Use water-reducing admixtures in accordance with Subarticle 1000-4(G).

(G) Use of Calcium Nitrite Corrosion Inhibitor

Add an approved calcium nitrite corrosion inhibitor (30% solids) to the concrete mix at the batch plant for the bridge elements identified by the plan notes. Clearly mark the prestressed concrete members that contain calcium nitrite.

Use the inhibitor at a minimum rate of 3.0 gal/cy. Ensure that the hardened concrete contains at least 5.1 lb/cy Nitrite (NO₂) when tested in accordance with Materials and Tests Method Chem. C-20.0 with the exception of concrete used in prestressed members. Test prestressed members as follows:

The Department will perform the complete C-21.0 Field Test Procedure for the Nitrite Ion in Plastic Concrete on plastic concrete samples obtained randomly from a truck used to pour concrete near each end (live end and dead end) of a prestressed concrete casting. Powder samples will be taken from hardened cylinders made at the time C-21.0 is run for any concrete that fails the C-21.0 (plastic test) method. The Chemical Testing Laboratory will test the powder using method C-20.0 Determination of Nitrite in Hardened Concrete. Acceptance of the concrete is dependent in the results of method C-20.0 (hardened test) when any sample fails the C-21.0 (plastic test method).

The Department will perform a qualitative nitrite ion check by method C-22.0 (Field Spot Test) on each load of concrete batched for a prestressed concrete casting bed. Acceptance of the concrete is dependent on the results of method C-20.0 (hardened test) when any sample fails the C-22.0 (Field Spot Test). The producer may elect to not incorporate concrete that fails Method C-22.0 (Field Spot Test) instead of waiting for C-20.0 (hardened test) test results to determine the acceptability of the member. Once per each week's production of prestressed concrete with corrosion inhibitor, random samples of hardened concrete powder will be taken from cylinders used for method C-21.0 (plastic test). These samples will be submitted to the Chemical Testing Laboratory for analysis using method C-20.0 (hardened test).

Units with calcium nitrite in a quantity less than specified are subject to rejection. Furnish concrete cylinders to the Engineer, in a quantity to be specified, to verify the concentrations of calcium nitrite in hardened concrete. Concrete failing to contain calcium nitrite at the required concentrations as tested is subject to rejection.

Use only air-entraining, water-reducing and/or set-controlling admixtures in the production of concrete mixtures that are compatible with calcium nitrite solutions.

Strictly adhere to the manufacturer's written recommendations regarding the use of admixtures including storage, transportation and method of mixing. If preferred, use calcium nitrite, which acts as an accelerator, in conjunction with a retarder to control the set of concrete, as per the manufacturer's recommendation.

(H) Measuring Materials

Measure materials in accordance with Article 1000-8.

(I) Mixers and Agitators

Use mixers and agitators meeting Article 1000-10.

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1 (J) Mixing and Delivery

2 (1) General

3 Mix and deliver concrete to the site of the work by one of the following methods,
4 except where other methods are approved by the Engineer. The Engineer approves
5 the mixing of concrete by methods other than those listed below provided the
6 proposed method is capable of satisfying job requirements and there is adequate
7 evidence that the proposed method produces concrete complying with the *Standard*
8 *Specifications*. Assume responsibility for controlling the materials and operations so
9 as to produce uniform concrete meeting the *Standard Specifications*.

10 Have present during all batching operations at the concrete plant a certified concrete
11 technician employed by the Contractor, prestressed concrete producer or concrete
12 supplier while concrete is batched and delivered to the site of the work. The sole
13 duty of this employee is to have charge of and exercise close supervision of the
14 production and control of the concrete. Ensure the technician performs moisture
15 tests, adjusts mix proportions of aggregates for free moisture, completes batch tickets
16 on M&T Form 903 or approved delivery tickets, signs batch tickets or approved
17 delivery tickets and assures quality control of the batching operations. Delivery
18 tickets are permitted instead of batch tickets on M&T Form 903 provided they are
19 reviewed and approved by the Materials and Tests Unit. Certification of technicians
20 is awarded upon satisfactory completion of examinations prepared and administered
21 by the Department or other approved agency.

22 (a) Central Mixed Concrete

23 Mix completely in a stationary mixer and transport the mixed concrete to the
24 point of delivery in a truck agitator or in a truck mixer operating at agitating
25 speed or in non-agitating equipment approved by the Engineer. Mix within the
26 capacity and at the mixing speeds recommended by the equipment
27 manufacturer.

28 (b) Transit Mixed Concrete

29 Mix completely in a truck mixer while at the batching plant, in transit or at the
30 work site.

31 (2) Mixing Time for Central Mixed Concrete

32 The mixing time starts when all the solid materials are in the mixing compartment
33 and ends when any part of the concrete begins to discharge. Charge the ingredients
34 into the mixer such that some of the water enters in advance of cement and
35 aggregate, and substantially all the water is in the drum before 1/3 of the specified
36 mixing time elapses. Transfer time in multiple drum mixers is counted as part of the
37 mixing time.

38 Establish the minimum mixing time by one of the following:

39 (a) Mixer performance tests as described herein,

40 (b) The manufacturer of the equipment, or

41 (c) The requirement of one minute for mixers of 1.0 cy capacity or less with
42 an increase of 15 seconds for each cubic yard or fraction thereof in increased
43 capacity.

44 The Engineer reserves the right to require a mixer performance test at any time. The
45 minimum mixing time as determined by the mixer performance test is that which
46 produces concrete in accordance with Table 1078-2.

1 Sample and test for mixer performance as provided below. Charge the mixer to its
 2 rated capacity with the materials and proportions used in the work and mix at the
 3 recommended mixing speed to the target time. Stop mixing then and begin
 4 discharging. Take 2 samples of sufficient size to make the required tests after
 5 discharge of approximately 15% and 85% of the load by an appropriate method of
 6 sampling which provides representative samples of the concrete.

7 Separately test each of the 2 samples of concrete for the properties listed in
 8 Table 1078-2. Conduct tests in accordance with the standard methods shown in
 9 Table 1078-2 or procedures established by the Materials and Tests Unit.

10 Perform the mixer performance test described above on at least 2 batches of
 11 concrete. For the performance test to be acceptable, ensure that all tests in each
 12 batch meet the requirements listed above.

13 The Engineer rechecks mixer performance at any time when in his judgment
 14 acceptable mixing is not accomplished.

15 Where acceptable mixing cannot be accomplished in the established mixing time, the
 16 Engineer increases the mixing time or requires that the mixer be repaired or replaced
 17 before any further mixing.

18 (3) Truck Mixers and Truck Agitators

19 Use truck mixers and truck agitators meeting Subarticle 1000-11(C). For concrete
 20 with a design 28 day compressive strength greater than 6,000 psi, load trucks to
 21 within 1 cy of rated capacity and mix at a speed of 16 to 18 rpm.

22 (4) Delivery

23 For central mixed concrete delivered in truck agitators, truck mixers, or transit mixed
 24 concrete, use a ticket system for recording the transportation of batches from the
 25 proportioning plant to the site of the work. Fill out the tickets on M&T Form 903 or
 26 approved delivery tickets in accordance with the instructions issued by the Engineer.
 27 Issue the tickets to the truck operator at the proportioning plant for each load and
 28 have them signed by the certified concrete technician, which signifies that the
 29 concrete in the truck is inspected before departure. Show on each ticket the time
 30 batching is complete and if transit mixed, the number of revolutions at mixing speed,
 31 if any, at the plant. Deliver the tickets to the inspector at the site of the work. For
 32 central mixed concrete delivered in non-agitating equipment, alternate methods of
 33 documenting batch proportions are considered by the Engineer. Loads that do not
 34 arrive in satisfactory condition within the time limits specified are not acceptable for
 35 use in the work.

36 (K) Ready Mixed Concrete Plant

TABLE 1078-2		
REQUIREMENTS FOR UNIFORMITY OF CONCRETE WITHIN A BATCH		
Property	Requirement	Test Method
Difference in Test Samples Air Content, Percent by Volume of Concrete	1.0%	AASHTO T 152
Slump	1.0"	AASHTO T 119
Coarse aggregate content, portion by weight of each sample retained on the No. 4 sieve	6.0%	-
Weight per Cubic Foot (Density)	1.0 lb/cf	AASHTO T 121
Average Compressive Strength at 7 days, Percent of Average	7.5% ^A	AASHTO T 22 and T23

37 **A.** Obtain tentative approval pending 7 day compressive strength tests.

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1 Ensure ready mixed concrete plants are inspected and approved by the Department before
2 they are used to produce concrete for the project. Ensure that plants meet all applicable
3 requirements of the *Standard Specifications* and in addition have at least 2 acceptable
4 concrete delivery vehicles that are in working condition. Plants approved by the
5 Department are placed on a list of approved plants that is made available. All plants are
6 subject to reinspection at intervals selected by the Engineer. Reapproval after each
7 inspection is contingent on continuing compliance with the *Standard Specifications*

8 **1078-5 CASTING BED AND FORMS**

9 Use metal forms, including headers or end forms, except where other materials are approved
10 by the Engineer. Use forms of adequate thickness, braced, stiffened, anchored and aligned
11 adequately to consistently produce members within the limits of dimensional tolerances.
12 Design and align the forms so they do not restrict longitudinal movement of the casting when
13 the prestressing force is transferred. Provide corners and angles that are chamfered or
14 rounded. Provide joints in forms that are smooth and tight enough to prevent leakage of
15 mortar. Plug holes and slots in forms, pallets, headers and bulkheads neatly to prevent
16 leakage of mortar. Make the inside surfaces of forms accessible for cleaning. Thoroughly
17 clean the beds and forms after each use. Before casting, clean the inside surfaces of the forms
18 from rust, grease or other foreign matter. Remove all foreign substances from inside the
19 forms, including any standing water. Do not allow coatings used for release of members to
20 build up. Do not use forms that do not present a smooth surface.

21 When casting holes through the top flange of Bulb Tee Girders for overhang or interior bay
22 falsework hanger rods, use rigid PVC conduits with a wall thickness of approximately 1/8".
23 Do not use thin wall material. Secure conduits in the forms so they do not migrate out of the
24 proper location. Other methods of forming holes may be proposed but are subject to the
25 Engineer's approval.

26 When casting dowel rod holes in cored slab or box beam members, use material that creates
27 round, vertical holes of the specified diameter and in the correct location. Do not use material
28 that deforms, collapses or shifts position during casting of the member.

29 Apply form release agents to the forms either before or after stringing of strands. If applied
30 before stringing, provide a release agent of a type that dries to a degree so it cannot
31 contaminate any strand that comes in contact with it. If the release agent is applied after
32 stringing, exercise great care and provide a sheet metal or similar type shield for protection of
33 the strands.

34 **1078-6 TENSIONING DEVICES**

35 Use tensioning devices adequate to produce and maintain the required tension in all strands
36 until the concrete reaches the required transfer strength. Equip all jacks with accurate and
37 calibrated gauges for registering jacking loads. Calibrate gauges with the jacks with which
38 they are used. Calibrate all jacks and gauges by an approved testing company at no cost to the
39 Department at intervals not to exceed 12 months. During progress of the work, if gauge
40 readings and elongations indicate materially differing loads, recalibrate as required. Use
41 gauges with a full load capacity of 1 1/2 to 2 times their normal working load, unless
42 otherwise approved. Do not use loads less than one-fourth or more than 3/4 of the total
43 graduated gauge capacity unless calibration data clearly establishes consistent accuracy over
44 a wider range. Use gauges with indicating dials at least 6" in diameter and gauge pointers that
45 do not fluctuate, preventing an accurate reading, but remain steady until the jacking load is
46 released. Ensure that all gauges have an accuracy of reading within 2%. Provide means for
47 measuring the elongation of strands within 1/4".

1 1078-7 PLACING STRANDS, TIES AND REINFORCING STEEL

2 Position strands, ties, supports, reinforcing bars of the sizes shown in the plans and bearing
3 plates in accordance with the detailed dimensions shown in the plans and effectively secure
4 against displacement from their correct positions. The use of previously tensioned strands is
5 not permitted. For prestressing strands, do not allow deflections or displacements of any kind
6 between the end anchorages unless shown in the plans. Place the steel reinforcing in final
7 position after tensioning of the strands. Bend all tie wires to the inside of the member so the
8 ends are farther from the edge than the material tied. Support bottom strands spacings not to
9 exceed 20 ft by supports meeting Article 1070-4 or by other approved means. Plastic
10 supports may be used when approved.

11 Strands with kinks, bends, nicks, scale, excessive rust or other defects are not permitted. No
12 more than one broken wire per casting bed is permitted. Slight rusting is not cause for
13 rejection, provided it is not sufficient to cause visible pits. Take precautions to prevent
14 contamination of strands and reinforcing steel. Clean the strands and reinforcing steel to an
15 acceptable condition before pouring concrete. Do not place concrete in the forms until the
16 strand and reinforcement condition and arrangement are inspected by the plant inspector.

17 Strand splices are only permitted at the end of a reel and when using a single strand jack.
18 Ensure that the strand lengths to be spliced together have the same lay of wire to avoid
19 unraveling and position the splice so it does not fall within a member. Do not torch cut the
20 ends of the spliced strand lengths. Cut by shears, abrasive grinders or other means approved
21 by the Engineer. No more than one strand splice per bed is allowed on an individual strand
22 and the use of previously tensioned strands for splicing is not permitted.

23 Where debonding of strands is required, accomplish by encasing the strand in a tubular
24 conduit capable of resisting the pressure exerted by the concrete. Do not use slit conduit. Use
25 a conduit of HDPE or polypropylene with a minimum wall thickness of 0.025". Ensure that
26 the inside diameter of the conduit is of sufficient size to allow free movement of the encased
27 strand but not greater than the diameter of the strand plus 1/8". Secure the conduit so
28 longitudinal movement along the strand is prevented, and bonding of the strand is prevented
29 at the required location ± 1 ". Prevent concrete from entering the conduit by taping. Use tape
30 manufactured from a non-corrosive material compatible with the concrete, conduit and steel.

31 1078-8 TENSIONING PROCEDURE

32 A producer quality control representative shall be present during strand tensioning. Tension
33 each strand to the load shown in the plans before placing the concrete.

34 Measure the load induced in the prestressing strand both by jacking gauges and strand
35 elongations on at least the first 5 strands and every third strand thereafter on each pour.
36 Measure loads on all other strands by either jacking gauges or strand elongations. When both
37 methods of measurement are used, if a discrepancy between gauge and elongation of more
38 than 5% is apparent, carefully check the entire operation and determine the source of error
39 before proceeding. Make appropriate allowances in the computed elongation and jacking
40 loads for load losses due to friction and all possible slippage or relaxation of the anchorage.
41 Establish references periodically at each strand anchorage to indicate any yielding or slippage
42 that may occur between the time of initial tensioning and final release of the strands.

43 In determining the applied load by measuring the elongation of the strand, use a modulus of
44 elasticity taken from the typical stress-strain curve for the brand, size and type of strand
45 tensioned. Submit stress-strain curve data for the actual heats of material used in the strands
46 to the plant inspector before using the strands. Identify each reel or strand by tagging in
47 accordance with AASHTO M 203. Mark the outer layer of each reel pack of strand with a
48 wide color band as follows: white for 270K stress relieved strand, green for low relaxation
49 strand and a double marking of green and red for special low relaxation strand. In addition,
50 attach a metal tag to each reel pack labeled in accordance with AASHTO M 203.

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1 Tension strands in a group or individually. Before full tensioning, bring each strand to
2 an initial tension of 2,000 lb for all beds under 150 ft in length, 3,000 lb for all beds 150 ft to
3 300 ft in length and 4,000 lb for all beds longer than 300 ft in length. Measure this initial
4 tension by a calibrated gauge or other approved means, and then compute the elongation due
5 to initial tensioning. Use the difference between the required final tension and the initial
6 tension to compute the expected additional elongation.

7 For precast prestressed deck panels, use a final prestressing force of 14,000 lb per strand for
8 Grade 250 strand and 16,100 lb per strand for Grade 270 strand.

9 After initial tensioning, tension the strands until the required elongation and jacking load are
10 attained and reconciled within the limits specified above. Keep a permanent record of the
11 initial jacking load, the final jacking load, and the elongation produced thereby.

12 In single strand tensioning, rotation of the jacking ram is not allowed.

13 When draped strands are used, submit 6 sets of the bed layout showing the method of draping
14 and tensioning the draped strands and also calculations determining the loads required for
15 tensioning the draped strands. Drape the strands for all members to be cast in any one
16 tensioning operation before casting any beam. Have end templates or bulkheads at ends of
17 beams remain vertical or as otherwise shown in the plans. Perform draping for all members
18 either simultaneously or in single or incremental lifts beginning at the center of the bed and
19 working outward toward each end of the bed. Complete tensioning in the fully draped
20 position is not allowed unless approved in writing.

21 Use round steel rollers of a type and dimensions approved by the Engineer for deflecting the
22 draped strands. Round the part in contact with the strand to a diameter of not less than 3/4".
23 Use support and hold-down devices of sufficient rigidity with adequate support so the final
24 position of the strands is as shown in the plans.

25 With strands tensioned in accordance with the above requirements and with other
26 reinforcement in place, cast the concrete members so as to achieve the required lengths.
27 Maintain strand load between anchorages until the concrete reaches the required compressive
28 strength for transfer of load from the anchorages to the members.

29 For personnel engaged in the tensioning operation, provide protection by effective shields
30 adequate to stop a flying strand. Provide shields produced from steel, reinforced concrete,
31 heavy timbers and other approved material at both ends of the bed.

32 **1078-9 PLACING CONCRETE**

33 Place concrete in accordance with Article 1077-8 and the additional requirements of this
34 article.

35 Upon completion of stressing strand, place concrete within a reasonable time to prevent
36 contamination of the strands and reinforcing steel.

37 Place concrete for girders 54" or less in height, and concrete for all cored slabs and box
38 beams, in 2 or more equal horizontal layers. Place concrete for girders over 54" in height in
39 3 horizontal layers. When placing concrete in 3 layers locate the top of the first layer
40 approximately at the top of the bottom flange and locate the top of the second layer
41 approximately at the top of the web. To prevent separation of surfaces between layers, do not
42 allow the time between successive placements onto previously placed concrete to exceed
43 20 minutes, unless the previously placed concrete has not yet stiffened, as evidenced by the
44 continuous effective use of vibration. Should shrinkage or settlement cracks occur, the
45 Engineer reserves the right to require additional layers and/or vibration.

46 The requirement of the above paragraph may be waived with the permission of the Engineer if
47 self consolidating concrete is used.

48 Internal or a combination of internal and external vibration is required as is necessary to
49 produce uniformly dense concrete without honeycomb.

- 1 Place concrete in cold weather in accordance with Article 420-7.
- 2 Place concrete in daylight unless an adequate lighting system meeting the approval of the
3 Engineer is provided.
- 4 Do not exceed a temperature of 95°F in the freshly mixed concrete when placed in the forms.
- 5 Place the concrete in the bed in one continuous operation, finishing each member before
6 proceeding to the next one. If the pour stops before the concrete in all the members in the bed
7 is placed, start curing immediately. Do not place concrete in any remaining members in that
8 bed setup once curing at elevated temperatures has begun.
- 9 When cored slabs and box beams are cast, employ an internal hold-down system to prevent
10 the voids from moving. At least 6 weeks before casting cored slabs or box beams, submit to
11 the Engineer for review and comment, detailed drawings of the proposed void material and
12 hold-down system. In addition to structural details, indicate the location and spacing of the
13 holds-downs. Submit the proposed method of concrete placement and of consolidating the
14 concrete under the void.

15 **1078-10 CURING CONCRETE**

16 **(A) General**

17 Cure concrete by steam curing, radiant heat curing or water curing, as set forth below.
18 As an option, cure concrete for prestressed piles with membrane curing compound as set
19 forth below. Use a method or methods that prevent the concrete from losing moisture at
20 any time before curing is complete. Use methods that do not deface or injure the
21 concrete. Use curing procedures that prevent cracks from occurring in the members.
22 Cure all members in any one bed by the same method.

23 Continue the curing period until the concrete reaches sufficient strength to permit transfer
24 of load from the anchorage to the members. As soon as the concrete attains release
25 strength, immediately release all forms in a continuous operation, without delay for other
26 activities such as the cleaning of forms. Immediately following the removal of the forms,
27 de-tension the members.

28 **(B) Curing at Elevated Temperatures**

29 Perform radiant heat curing under a suitable enclosure that contains the heat and prevent
30 moisture loss. Apply moisture by a cover of moist burlap, cotton matting, or similar
31 approved material. Retain moisture by covering the member with an approved
32 waterproof sheeting in combination with an insulating cover. Support the cover at
33 a sufficient distance above the member being cured to allow circulation of the heat.

34 Provide steam curing enclosures essentially free of steam leakage to minimize moisture
35 and heat losses. Do not allow the enclosure to come in contact with the members or
36 forms for the members. Do not direct steam jets on the forms so as to cause localized
37 high temperatures.

38 After placing and vibrating, allow the concrete to attain its initial set before the
39 application of heat or steam. The concrete is considered to obtain its initial set when it
40 has a penetration resistance of at least 500 psi when tested in accordance with
41 AASHTO T 197. Take the sample of concrete tested for penetration resistance from the
42 last load cast in the bed. Store the sample of concrete with the precast member and
43 maintain in the same condition and environment as the member except for the periods of
44 time necessary to prepare the test specimen and to perform the penetration resistance test.
45 Conduct the penetration resistance test.

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1 As an option, submit data indicating that an approved concrete mix attains its initial set
2 after some particular time period. Different periods may be required for different weather
3 conditions. If such data is submitted, consideration is given to permitting heat or steam
4 introduced after the time indicated by such data instead of having to perform the
5 penetration resistance test. Consideration is given to determining the time of initial set by
6 methods other than AASHTO T 197 provided data supporting such other methods is
7 submitted.

8 When the ambient air temperature is below 50°F, cover the forms after the placement of
9 concrete and apply sufficient heat to maintain the temperature of the air surrounding the
10 unit between 50° and 70°F.

11 When the ambient air temperature is above 70°F, start a water cure as set forth below or
12 other approved method as soon as the concrete is able to receive the water without
13 physical damage to its surface. Discontinuation of the cure is allowed upon introduction
14 of steam, provided that a relative humidity of 100% is maintained.

15 Cure at elevated temperatures at a temperature of not more than 160°F.

16 Maintain a relatively uniform rate of increase of the temperature within the curing
17 enclosure of approximately 40°F per hour, not to exceed 15°F per 15 minutes. Ensure
18 that the temperature increase is relatively uniform throughout the length and on both
19 sides and top of the concrete unit. Place recording thermometers within 50 ft of each end
20 of the bed and at points not to exceed 100 ft between the end thermometers. Provide at
21 least 2 thermometers for bed lengths of 100 ft or less. Calibrate recording thermometers
22 at intervals not to exceed 6 months. Ensure that the temperature differential within the
23 curing enclosure does not exceed 15°F. Submit complete temperature records for all
24 cures before final approval of the members.

25 Continue steam curing until the concrete reaches the required transfer strength.

26 (C) Water Curing

27 Keep the concrete continuously wet by the application of water as soon as possible
28 without damage to the concrete surface, and before the concrete obtains an initial set of
29 500 psi. Apply the water using soaker hoses and wet burlap or other approved means for
30 the full length of each member. Apply water evenly along the entire length of the bed.

31 When the ambient air temperature is below 50°F cover the forms after the placement of
32 the concrete and apply sufficient heat in an approved manner to maintain the temperature
33 of the air surrounding the member between 50°F and 70°F. After the concrete obtains
34 an initial set of 500 psi, the air temperature surrounding the member is allowed to
35 increase to 100°F while continually maintaining moisture on the surface of the concrete.
36 Whenever heat is applied to the member, place temperature recording clocks on the bed
37 as required when curing at elevated temperatures. The requirements for rate of
38 temperature increase apply.

39 Maintain the application of heat (if used) and water until the concrete obtains release
40 strength.

41 (D) Curing with Membrane Curing Compound

42 As an option, cure prestressed concrete piles with a membrane curing compound. Spray
43 the entire surface of the concrete uniformly with a wax-free, resin-base curing compound
44 conforming to Article 1026-2. Use clear curing compound to which a fugitive dye is
45 added for color contrast.

1 Apply the membrane curing compound after the surface finishing is complete, and
2 immediately after the free surface moisture disappears. In the event the application of
3 curing compound is delayed, start another curing method immediately and continue until
4 the application of the curing compound is started or resumed or until the concrete reaches
5 the required detensioning strength.

6 Seal the surface with a single uniform coating of the specified type of curing compound
7 applied at the rate of coverage recommended by the manufacturer or as directed by the
8 Engineer, but not less than one gallon per 150 sf of area.

9 At the time of use, thoroughly mix the compound in a condition with the pigment
10 uniformly dispersed throughout the vehicle. If the application of the compound does not
11 result in satisfactory coverage, stop the method and apply water curing, as set out above,
12 until the cause of the defective work is corrected.

13 At locations where the coating shows discontinuities, pinholes, or other defects, or if rain
14 falls on the newly coated surface before the film dries sufficiently to resist damage, apply
15 an additional coat of the compound immediately after the rain stops at the same rate
16 specified herein.

17 When the ambient air temperature is below 50°F, cover the forms after the application of
18 the curing compound and apply sufficient heat in an approved manner to maintain the
19 temperature of the air surrounding the member between 50°F and 70°F. Whenever heat
20 is applied to the members, place recording thermometers on the bed as required when
21 curing at elevated temperatures. The requirements for rate of temperature increase also
22 apply.

23 Completely remove any curing compound adhering to a surface to which new concrete is
24 bonded by sandblasting, steel wire brushes, bush hammers or other approved means.

25 Protect the concrete surfaces to which the compound is applied from abrasion or other
26 damage that results in perforation of the membrane film until the concrete achieves
27 design strength and the members are de-tensioned.

28 **1078-11 TRANSFER OF LOAD**

29 A producer quality control representative or equivalent qualified personnel shall be present
30 during removal of forms and during transfer of load.

31 Transfer load from the anchorages to the members when the concrete reaches the required
32 compressive strength shown in the plans. Loosen and remove all formwork in one continuous
33 operation as quickly as possible as soon as release strength is obtained. As soon as the forms
34 are removed, and after the Department's Inspector has had a reasonable opportunity to inspect
35 the member, transfer the load from the anchorages to the members as quickly as possible in
36 one continuous operation using the approved detensioning sequence.

37 For any particular group of members cast in the same bed, do not transfer the load to any
38 concrete until the test cylinder breaks indicate that the concrete in all these members has
39 reached the required strength as outlined in Subarticle 1078-4(B)(3). If these conditions are
40 not met, delay the transfer of the prestressing load to the concrete until tests of additional
41 cylinders show that the required strength is reached.

42 When curing at elevated temperatures, begin the procedures for transferring prestressing load
43 immediately after curing is discontinued and the forms are released, and while the concrete is
44 still hot to prevent cooling shrinkage and cracking. If so directed by the Engineer, cover
45 members or otherwise protect so as to cool the concrete slowly after release to prevent
46 thermal shock and the evaporation of moisture in the members.

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1 Transfer load to not cause cracks in members. Transfer load by gradual release of the strands
2 as a group, by gradual release of part of the group, or by burning the fully tensioned strands at
3 the ends of the members. If intending to release the strands by a method other than gradual
4 release of the entire group, submit 6 copies of the proposed method and pattern of release, if
5 not so shown in the plans, for approval. Rigidly follow the approved method and pattern of
6 release. When the fully tensioned strands are burned, burn each strand or group of strands
7 simultaneously at each end of the bed in its indicated order in the pattern and at each end of
8 each member before proceeding to the strands in the next group in the pattern at any point.
9 Because of the critical nature of the bond development length in prestressed concrete panel
10 construction, if transferring of stress by burning the fully tensioned strands at the ends of the
11 member, burn each strand first at the ends of the bed and then at each end of each member
12 before proceeding to the next strand in the burning pattern.

13 When detensioning all girders, box beams, cored slabs, piles, and panels do not burn strands
14 quickly but heat with a low oxygen flame played along the strand for at least 5" until the
15 metal gradually loses its strength. Apply heat at such a rate that failure of the first wire in
16 each strand does not occur until at least 5 seconds after heat is first applied. When
17 detensioning other members, follow the above procedure unless an alternate procedure is
18 approved. Detensioning by arc welder is not allowed.

19 Incorporate the following in the method for single strand detensioning of members having
20 draped strands:

21 (A) Release the pair of straight strands located in the uppermost position in the lower flange
22 first.

23 (B) Then release the tension in the draped strands at the ends and uplift points in accordance
24 with an approved pattern.

25 (C) Disengage all hold-down devices for draped strands and release the hold-downs.

26 (D) Then release the pair of straight strands located in the upper flange.

27 (E) Release the remaining straight strands of the pattern in accordance with an approved
28 sequence.

29 (F) Release all strands in a manner meeting the Engineer's approval that will cause
30 a minimum shock and lateral eccentricity of loading.

31 Failure to follow the above procedures for transfer of load is ground for rejection of the
32 members involved.

33 **1078-12 VERTICAL CRACKS IN PRESTRESSED CONCRETE GIRDERS BEFORE** 34 **DETENSIONING**

35 This section addresses prestressed concrete members that have vertical casting cracks before
36 strand detensioning. Certain types of these cracks have been determined by the Department to
37 render the girders unacceptable.

38 Unacceptable cracked members are those with 2 or more vertical cracks spaced at a distance
39 less than the member depth which extend into the bottom flange. Such members are not
40 serviceable and will be rejected. Members with 2 or more vertical cracks spaced at a distance
41 less than the member depth but do not extend into the bottom flange are subject to
42 an engineering assessment. Such members may not be serviceable and may be rejected.

43 Members with one or more vertical cracks that extend into the bottom flange and are spaced
44 at a distance greater than the member depth are subject to an engineering assessment to
45 determine their acceptability. If this engineering assessment is required, submit, at no
46 additional cost to the Department, a proposal for repairing the member and a structural
47 evaluation of the member prepared by an engineer licensed by the State of North Carolina.

1 In the structural evaluation, consider the stresses under full service loads had the member not
 2 cracked and the effects of localized loss of prestress at the crack as determined by methods
 3 acceptable to the Department.

4 All members, except those defined as unacceptable, which exhibit vertical cracks before
 5 detensioning, shall receive a 7 day water cure as directed by the Engineer. The water cure
 6 shall begin within 4 hours after detensioning the prestressing strands and shall be at least 3 ft
 7 beyond the region exhibiting vertical cracks.

8 The Department has the final determination regarding acceptability of any members in
 9 question.

10 **1078-13 PRESTRESSED CONCRETE GIRDER WEB SPLITTING**

11 After detensioning of certain girders with draped strands, cracks occasionally occur in the
 12 webs at the ends of the girders. If such cracks occur, employ a method to remedy this
 13 condition on all subsequent girders of the same type and strand pattern. If debonding of
 14 strands is used, satisfy the following criteria:

15 (A) Do not debond the 2 straight strands in the top of the girder. Debond 1/2 of the straight
 16 strands, as nearly as possible, in the bottom flange. As nearly as possible, debond 1/4 of
 17 the straight strands in the bottom of girder 4 ft from each end of the girder and debond
 18 1/4 of the straight strands 2 ft from each end of the girder.

19 (B) Use a debonding pattern that is symmetrical about the vertical axis of the girder.

20 (C) Debond strands so the center of gravity of the strands in the bottom of the girder remain
 21 within 1" of their original location at the end of the girder.

22 (D) Debond strands by encasing the strand in a conduit meeting the approval of the Engineer.
 23 Conduit may be rigid one-piece or rigid 2-piece split sheathing. Do not use flexible
 24 conduit or sheathing.

25 No separate payment is made for debonding strands as payment is included in the contract
 26 unit price bid for prestressed concrete girders.

27 **1078-14 HANDLING, TRANSPORTING AND STORING**

28 Members damaged while being handled or transported are rejected or require repair in
 29 a manner approved by the Engineer. All members are allowed to be handled immediately
 30 after transfer of load from the anchorages to the members is complete.

31 Store all prestressed members on solid, unyielding, storage blocks in a manner to prevent
 32 torsion or objectionable bending. In handling prestressed concrete girders 54" or less in
 33 height, including cored slabs and box beams, maintain them in an upright position at all times
 34 and pick them up within 5 ft of the points of bearing and transport and store supported only
 35 within 3 ft of points of bearing. In handling prestressed concrete girders greater than 54" in
 36 height, maintain them in an upright position at all times and submit for approval the proposed
 37 method of lifting, transporting, and storing the girders. When requested, provide calculations
 38 to confirm girders are not overstressed by such operations.

39 Prestressed concrete panels are weak in the direction perpendicular to the prestressing strands,
 40 therefore, they are subject to breakage during handling, storing or transporting. Provide
 41 adequate blocking during all of these construction phases.

42 In handling, transporting, and storing prestressed members, use the number and location of
 43 supports in accordance with the plan requirements for the sizes, lengths and types of members
 44 involved, or as approved.

45 When handling the prestressed concrete members, a temporary stress of $5\sqrt{f_{ci}}$ is permitted,
 46 where f_{ci} is the strength of concrete at release, in pounds per square inch.

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- 1 Do not transport members away from the casting yard until the concrete reaches the minimum
2 required 28 day compressive strength and a period of at least 5 days elapses since casting,
3 unless otherwise permitted.
- 4 Do not transfer any member from the plant to the job site before approval of that member by
5 the plant inspector. This approval is stamped on the member by the plant inspector.
- 6 **1078-15 FINAL FINISH**
- 7 Finish prestressed concrete members that are intended for composite action with subsequently
8 placed concrete or asphalt with a roughened surface for bonding. Make sure that no laitance
9 remains on the surfaces to be bonded.
- 10 Rough float the tops of girders. Broom finish the top surface of the cored slab and box beam
11 sections receiving an asphalt overlay. Rake the top surface of cored slab and box beam
12 sections receiving a concrete overlay to a depth of 3/8". No surface finish is required for sides
13 and bottom of the slab and beam sections except the exposed side of the exterior unit as noted
14 below. Provide a resulting surface finish essentially the same color and surface finish as the
15 surrounding concrete.
- 16 Provide a 3/4" chamfer along the bottom edges on ends and sides of all box beam and cored
17 slab sections, top outside edges of exterior sections and acute corners of sections. Round the
18 top edges on ends of all sections with a 1/4" finishing tool. Provide square corners along top
19 edges on all sections along shear keys. Do not chamfer vertical edges at ends of sections.
- 20 Fill all voids in the diagonal face of the bottom flange of prestressed concrete girders and the
21 outside face of exterior cored slabs and box beams with a sand-cement or other approved
22 grout. Fill all voids in piles greater than 1/2" in diameter or depth as above. Provide
23 a resulting surface finish essentially the same color and surface finish as the surrounding
24 concrete. Repair voids greater than 1/4" in diameter or depth in other faces of these and other
25 members except piles in a like manner. Where an excessive number of smaller voids exist in
26 any member, the Engineer requires a similar repair.
- 27 Repair honeycomb, excessively large fins, and other projections as directed. Submit, at no
28 additional cost to the Department, a proposal for repairing members with honeycomb, cracks
29 or spalls. Do not repair members containing honeycomb, cracks, or spalls until a repair
30 procedure is approved and the member is inspected by the Engineer. Any appreciable
31 impairment of structural adequacy that cannot be repaired to the satisfaction of the Engineer is
32 cause for rejection.
- 33 Clean and fill holes caused by strand hold downs upon removal from the casting bed. Use
34 patches of materials approved by the Engineer that develop strength at least equal to the
35 minimum 28 day strength requirement for the concrete before approval of the member.
36 Ensure that members are clean and surfaces have a uniform appearance.
- 37 Give the top surface of prestressed concrete panels a raked finish or other approved finish to
38 provide an adequate bond with the cast-in-place concrete. As soon as the condition of the
39 concrete permits, rake the top surface of the concrete making depressions of approximately
40 1/4". Take care when raking not to catch and pull the coarse aggregate.
- 41 Clean reinforcing bars exposed on the tops of girders and exterior cored slabs or box beams of
42 mortar build up and excessive rust.
- 43 Apply epoxy protective coating to the ends of prestressed members as noted in the plans.

1 **1078-16 ALIGNMENT AND DIMENSIONAL TOLERANCES**

2 **(A) Piles**

3 Manufacture piles within the tolerances indicated in Table 1078-3 and Figure 1078-1.

4 **(B) Cored Slabs**

5 To ensure a good, neat field fit, assemble cored slab spans in the yard and have pieces
6 matchmarked. Ensure that pieces fit together neatly and in a workmanlike manner.

7 Manufacture cored slabs within the tolerances indicated in Table 1078-4 and
8 Figure 1078-2.

9 **(C) Girders**

10 Manufacture girders within the tolerances indicated in Table 1078-5 and Figure 1078-3.

11 **(D) Prestressed Concrete Panels**

12 Manufacture prestressed concrete panels within the tolerances indicated in Table 1078-6.

13 **(E) Box Beams**

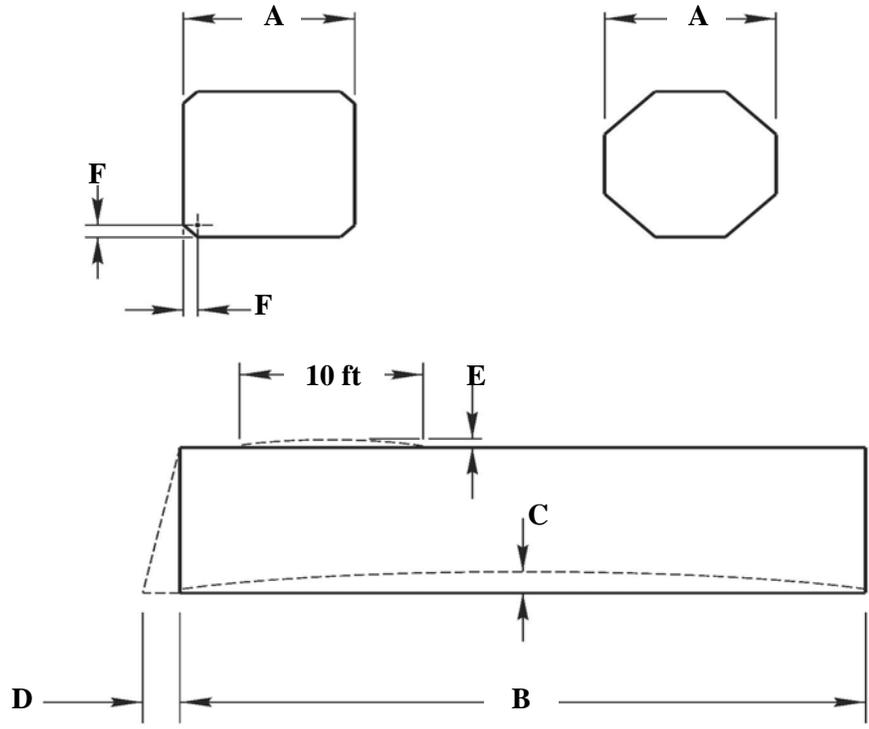
14 To ensure a good, neat field fit, assemble box beam spans in the yard and have pieces
15 match-marked. Ensure that pieces fit together neatly and in a competent manner.

16 Manufacture box beams within the tolerances indicated in Table 1078-7 and
17 Figure 1078-4.

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1 1078-17 IDENTIFICATION OF MEMBERS

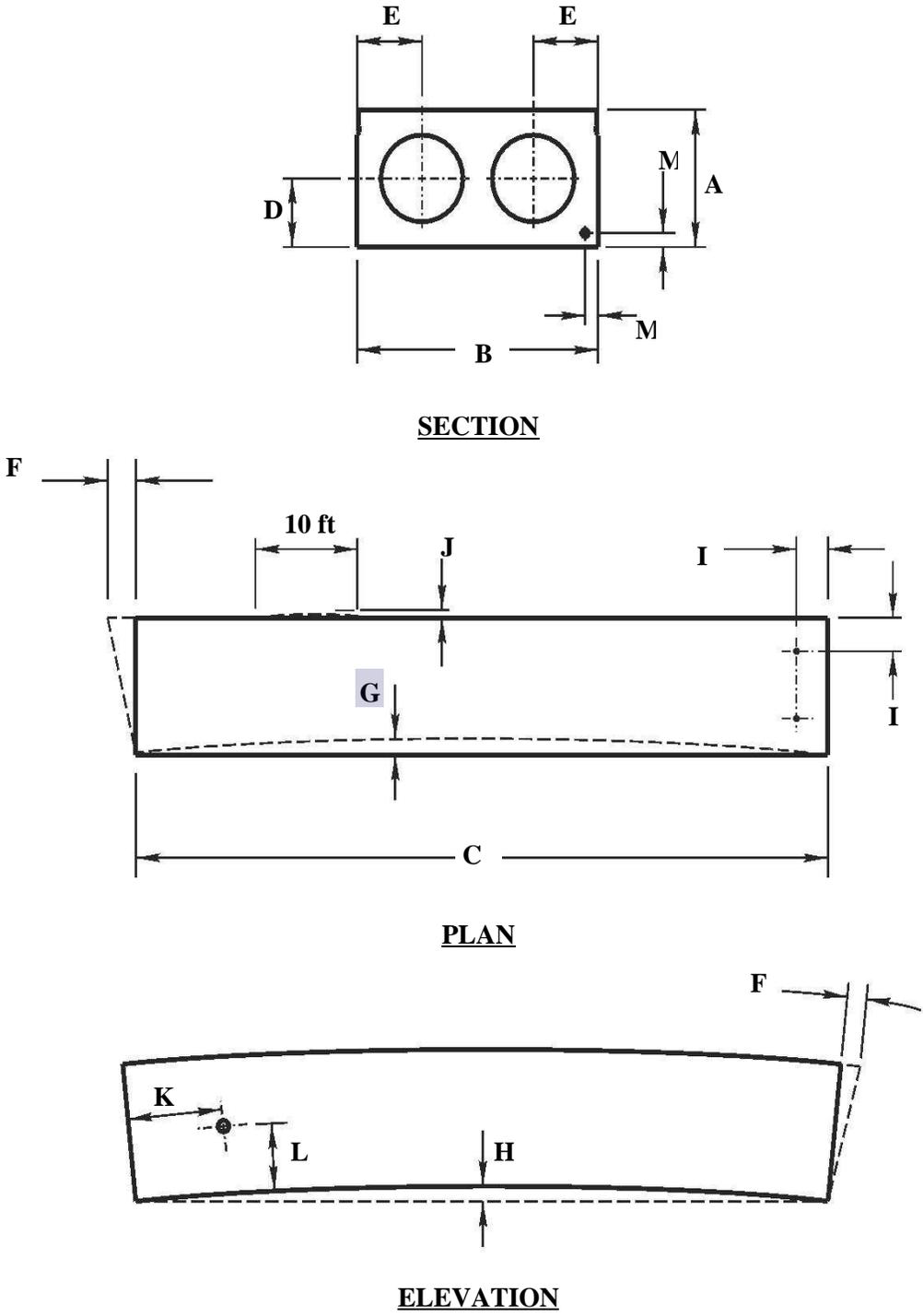
- 2 Permanently identify each prestressed member by number and date of manufacture, and paint
- 3 this information, or otherwise mark as approved by the Engineer, on at least one end of the
- 4 member as soon as practical after manufacture. In the case of girders or cored slabs, paint
- 5 other identification as to station, span and position within the span on at least one end of the
- 6 member.



7 Figure 1078-1. Prestressed Piles. Dimensions shown are in Table 1078-3.

TABLE 1078-3
TOLERANCES FOR PRESTRESSED PILES
 (Refer to Figure 1078-1)

Dimension	Tolerance
Width (A)	-1/4" to +3/8"
Length (B)	± 1 1/2"
Horizontal alignment Deviation from a straight line parallel to the centerline of pile (C)	1/8" per 10 ft
Squareness of ends (D)	1/8" per 12" of width, 3/16" max.
Local smoothness (E)	1/4" in 10 ft
Position of strands (F)	1/4"
Position of mild reinforcing steel, including spiral pitch	1/2"

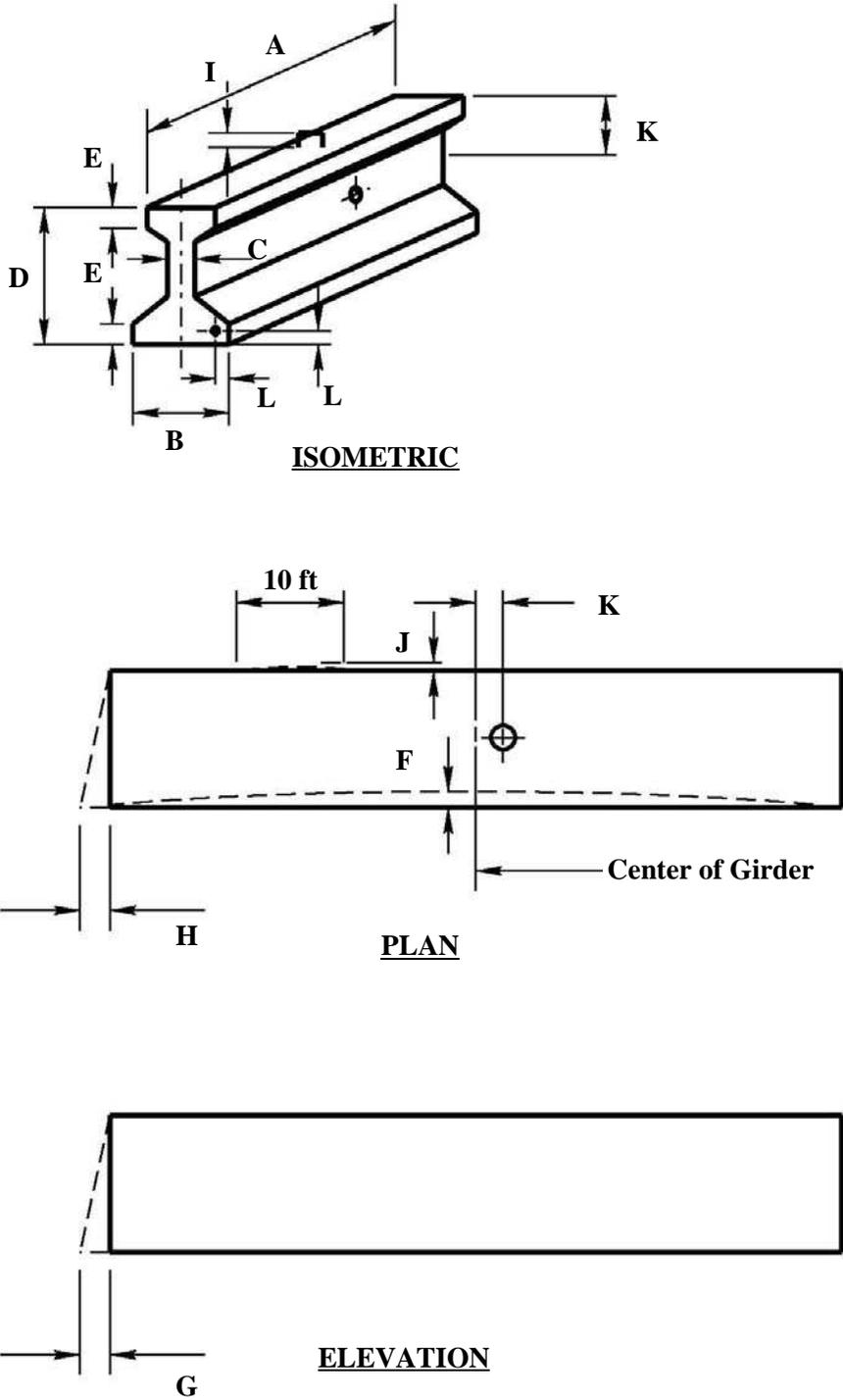


1 Figure 1078-2. Prestressed cored slabs. Dimensions shown are in Table 1078-4.

TABLE 1078-4 TOLERANCES FOR PRESTRESSED CORED SLABS (Refer to Figure 1078-2)	
Dimension	Tolerance
Depth (A)	+3/8" to -1/8"
Width (B)	± 1/4"
Length (C)	± 1/8" per 10 ft
Position of voids - Vertical (D)	± 3/8"
Position of voids - Horizontal (E)	± 3/8"
Position of void Ends – Longitudinal	+1", -3"
Square ends - Deviation from square (horizontal) or vertical) or designated skew (F)	±1/4"
Horizontal alignment - Deviation from a straight line parallel to the centerline of member (G)	0-30 ft long: 1/4" 30-50 ft long: 3/8" 50+ ft long: 1/2"
Camber - Differential between adjacent units (H)	1/4" per 10 ft, 3/4" max.
Camber - Differential between high and low members of same span (H)	3/4" max.
Position of dowel holes - Deviation from plan position (I)	1/4"
Width - Any one span	Plan width +1/8" per joint
Width - Differential of adjacent spans in the same structure	1/2"
Bearing area - Deviation from plane surface	1/16"
Local smoothness (J)	1/4" in 10 ft
Position of holes for transverse strands	Horizontal (K): ±1/2" Vertical (L): ±3/8"
Position of strands (M)	± 1/4"

1 **1078-18 QUALITY CONTROL**

- 2 Maintain a daily quality control record form approved by the Engineer including pertinent
3 information concerning tensioning, concrete quality and placement, curing and detensioning.
4 Have this form signed and dated by a certified concrete technician. Furnish a copy of the
5 completed or up-to-date form to the Materials and Tests Unit upon request and before any
6 members are approved. A sample form, indicating the minimum required information, is
7 available from the Materials and Tests Unit.



1 Figure 1078-3. Prestressed Girders. Dimensions shown are in Table 1078-5.

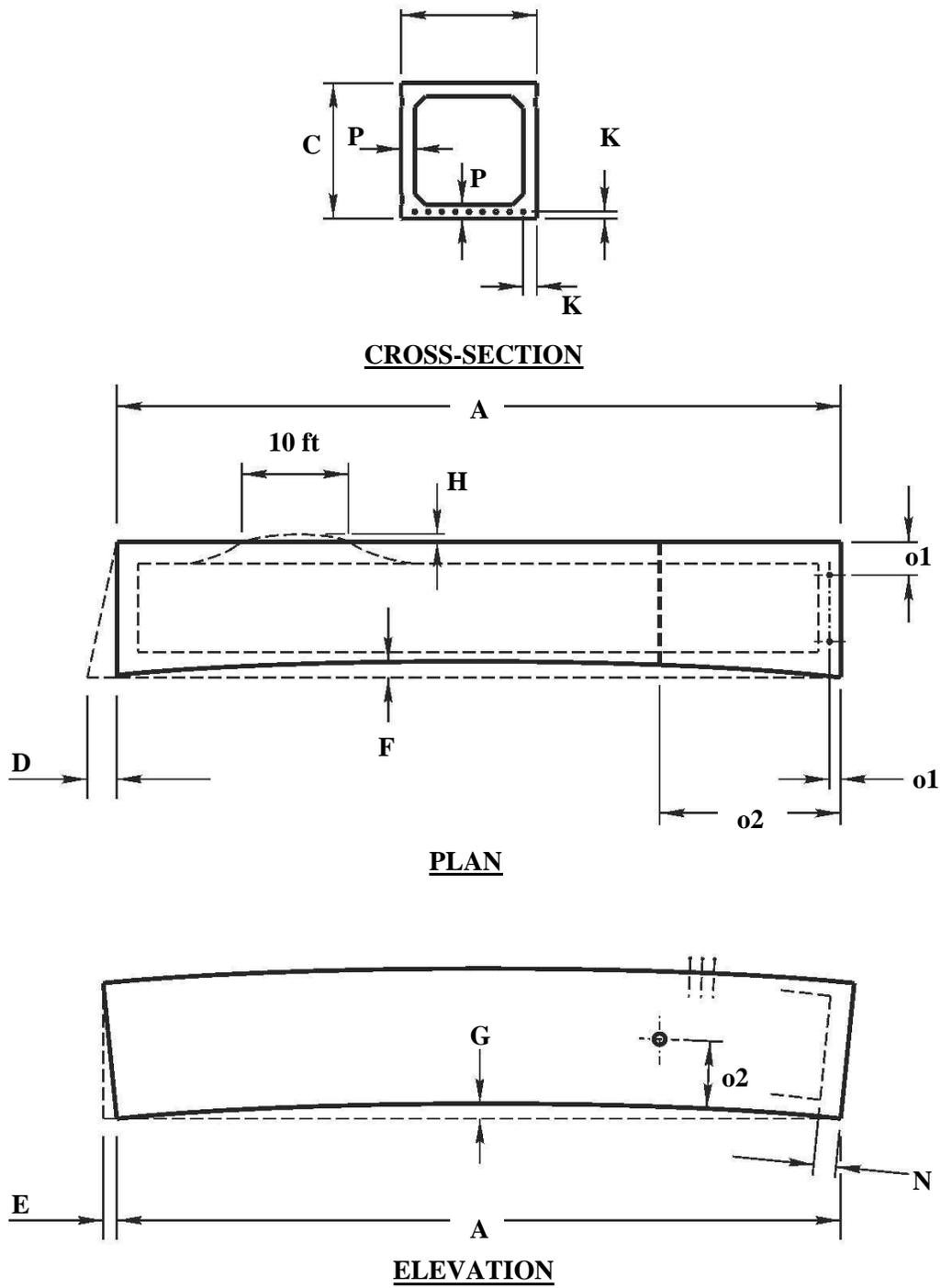
TABLE 1078-5 TOLERANCES FOR PRESTRESSED GIRDERS (Refer to Figure 1078-3)	
Dimension	Tolerance
Length (A) Girders 80 ft. or shorter	$\pm 1/8$ " per 10 ft
Length (A) Girders longer than 80 ft.	$\pm 1/8$ " per 10 ft Not to exceed 1 1/2"
Width - Flanges(B)	+3/8" to -1/8"
Width - Web (C)	+3/8" to -1/8"
Depth - Overall (D)	+1/2" to -1/4"
Depth - Flanges (E)	$\pm 1/4$ "
Horizontal alignment (top or bottom flange) Deviation from a straight line parallel to the centerline of beam (F)	$\pm 1/8$ " per 10 ft Not to exceed 1"
Bearing plate Deviation from plane surface	1/16"
Girder ends Deviation from square or designated skew (G and H)	Vertical (G): $\pm 1/8$ " per 12" of girder height Horizontal (H): $\pm 1/2$ "
Position of stirrups - Projection above top of girder (I)	$\pm 1/2$ "
Position of stirrups – Placement along girder length	± 1 "
Local smoothness of any surface (J)	1/4" in 10 ft
Position of holes for diaphragm bolts (K)	$\pm 1/4$ "
Position of strands (L)	$\pm 1/4$ "

- 1 Dimensions followed by an alphabetical suffix are shown in Figure 1078-3. The length (A) is
 2 measured along the top of the top flange. The tolerances at girder ends (G and H) are
 3 increased to 1" if the girder end is to be encased in a full depth concrete diaphragm.

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TABLE 1078-6 TOLERANCES FOR PRESTRESSED CONCRETE PANELS	
Dimension	Tolerance
Length (Transverse direction to girders)	-1/4" to +1/2"
Width (Longitudinal direction to girders)	-1/8" to +1/4"
Depth	0 to +3/8"
Position of Strand Horizontal Dimension	$\pm 1/8$ "
Vertical Dimension	$\pm 1/2$ "

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1 **Figure 1078-4. Prestressed Box Beams.** Dimensions shown are in Table 1078-7.

TABLE 1078-7 TOLERANCES FOR BOX BEAMS (Refer to Figure 1078-4)	
Dimension	Tolerance
Length (A)	+ 1"
Width (overall) (B)	+ 1/4"
Depth (overall) (C)	+ 1/4"
Variation from specified plan end squareness or skew (D)	+ 1/8" per 12" width, + 1/2" max
Variation from specified elevation end squareness or skew (E)	+ 1/8" per 12", + 1/2" max
Sweep, for member length (F) up to 40 ft	+ 1/4"
Sweep, for member length (F) 40 to 60 ft	+ 3/8"
Sweep, for member length (F) greater than 60 ft	+ 1/2"
Differential camber between adjacent members (G):	1/4" per 10 ft., 3/4" max
Local smoothness of any surface (H)	1/4" in 10 ft
Position of strands (K)	+ 1/4"
Longitudinal Position of blockout (N)	+ 1"
Position of dowel holes (o1)	+ 1/4"
Position of sleeves cast in beams, in both horizontal and vertical plane (o2)	+ 1/2"
Position of void (P)	+ 3/8"
Bearing area – deviation from plane surface	+ 1/16"
Width - Any one span	Plan width + 1/8" per joint
Width – Differential of adjacent spans in the same structure	1/2"

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SECTION 1079 BEARINGS AND BEARING MATERIALS

1079-1 PREFORMED BEARING PADS

Provide preformed bearing pads composed of multiple layers of 8 oz/sy cotton duck impregnated and bound with high quality natural rubber, or equally suitable materials approved by the Engineer, that are compressed into pads of uniform thickness. Ensure that the thickness of the preformed bearing pads is 3/16" with a tolerance of $\pm 1/16$ ". Use cotton duck that meets Military Specification MIL-C882-D for 8 oz/sy cotton army duck or equivalent. Provide enough pads as to produce the required thickness after compressing and vulcanizing. Ensure that the finished pads withstand compressive loads perpendicular to the plane of the laminations of not less than 10,000 psi without detrimental extrusion or reduction in thickness.

Furnish a Type 3 certification in accordance with Article 106-3 certifying that the preformed bearing pads meet this Specification.

1079-2 ELASTOMERIC BEARINGS

(A) General

Provide elastomeric bearings that meet the requirements of AASHTO M251, except as specified herein.

Manufacturers shall be pre-qualified by the Department and shall submit working drawings for approval. Refer to Subarticles 1079-2(D) and 1079-2(E). Furnish a Type 3 certification in accordance with Article 106-3 certifying that elastomeric bearings satisfy this Specification and all design criteria. Include the lot number, description and test results in the certification.

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1 (B) Elastomer Properties

2 The elastomer for all bearings shall be classified as Grade 3.

3 The shear modulus of the elastomer for laminated (reinforced) bearings shall be 160 psi,
4 unless otherwise noted in the plans.

5 Provide Grade 50 or Grade 60 durometer hardness elastomer in all (unreinforced)
6 bearings, unless otherwise noted in the plans.

7 (C) Testing

8 The optional test procedures of AASHTO M 251 are not required, except as specified
9 herein.

10 Determine the shear modulus of the elastomer for laminated (reinforced) bearings in
11 accordance with ASTM D4014.

12 At the Manufacturer's option, plain (unreinforced) bearings may be tested using the
13 methods of Appendices X1 and X2 of AASHTO M 251.

14 Test at least 2 bearings per lot or as directed by the Engineer. Define a "lot" as a group
15 of 100 or less bearings with or without holes or slots, which are:

16 (1) Manufactured in a reasonably continuous manner from the same batch of elastomer
17 and cured under the same conditions, and

18 (2) Of the same type (plain or laminated) and of similar size (no dimensions shall vary
19 by more than 40%).

20 A lot may include bearings from multiple projects and purchasers.

21 (D) Working Drawings

22 Submit 6 sets of detailed fabrication drawings of laminated (reinforced) bearings to the
23 Engineer for review, comments and acceptance. Show complete details and all material
24 specifications. Clearly identify any proposed deviations from details shown in the plans
25 or requirements of the Standard Specifications. Obtain drawing approval before
26 manufacturing of the bearings.

SECTION 1080

PAINT AND PAINT MATERIALS

27

28 1080-1 GENERAL

29 Deliver all paints except 2 component products to the project completely mixed and ready for
30 use without additional oil or thinner. Mix 2 component paints in accordance with the
31 manufacturer's printed instructions and shall not need additional oil or thinner upon mixing,
32 except where necessitated by weather conditions. Mixed paints or paint components that
33 harden or curdle in the container and will not break up with a paddle to form a smooth,
34 uniform consistency will be rejected. Any thinning necessitated by weather conditions shall
35 be approved in writing and use only those thinners approved by the manufacturer. Store all
36 paint materials in a moisture free environment between 40°F and 110°F or at such
37 temperatures within this range recommended by the manufacturer.

38 1080-2 PAINT VEHICLES, THINNERS AND DRIERS

39 Paint vehicles, thinners and dryers shall meet the requirements for these ingredients that are
40 included in the *Standard Specifications* for the paint being used. Only ingredients
41 recommended by the manufacturer which have a history of compatibility with each other may
42 be used.

1 1080-3 PACKING AND MARKING

2 Ship paint and paint materials in strong, substantial containers that are properly labeled and
3 plainly marked with the weight, color and volume in gallons of the paint content; a true
4 statement of the percentage composition of the pigment; the proportions of pigment to
5 vehicle; and the name and address of the manufacturer. Any package or container not so
6 marked as described above or exceeding 5 gallons total volume will not be accepted for use.

7 1080-4 INSPECTION AND SAMPLING

8 All paint will be sampled, either at the point of manufacture or at the point of destination.
9 Inspection and sampling will be performed at the point of manufacture wherever possible.
10 The Contractor shall not begin painting until the analysis of the paint has been performed, and
11 the paint has been accepted by the Engineer.

12 Use only pre-qualified inorganic zinc paint manufactured in accordance with the requirements
13 shown below.

14 Ensure the paint manufacturer submit the following at the same time to the State Materials
15 Engineer:

16 **(A)** A minimum one quart sample of each component of paint including the manufacturer's
17 name, location, product name, mixing instructions, batch number and MSDS.

18 **(B)** At least 3 panels prepared as specified in 5.5.10 of AASHTO M 300.

19 **(C)** A certified test report from an approved independent testing laboratory as specified in
20 5.5.8 and 5.5.9 of AASHTO M 300.

21 **(D)** A certified report from an approved independent testing laboratory that the product has
22 been tested for slip coefficient and meets AASHTO M 253, Class B.

23 Use the same batch of paint for all samples and panels. The independent testing laboratory
24 Report may be for a typical batch of the same product. Submit samples and reports for
25 qualification at least 30 days in advance of anticipated need. Once qualified, a product will be
26 placed on North Carolina's approved list for 5 years unless the formulation of the product or
27 manufacturing process is changed, in which case the product shall be requalified before use.

28 The Materials and Tests Unit will conduct all tests of paints in accordance with the latest
29 ASTMs, Federal Test Method Standard No. 141 and various other methods in use.

30 1080-5 RED PRIMER PAINT**31 (A) Scope**

32 This Specification covers a long oil-alkyd primer paint for use on steel surfaces blast-
33 cleaned to a SSPC-SP 6 finish. The paint may be applied by brushing or spraying to
34 a wet film thickness of approximately 3 wet mils per coat.

35 (B) Materials

36 Materials shall be as specified herein. Materials not specified shall be selected by the
37 supplier and will be subject to all of the requirements of this Specification. Use paint
38 made of materials that are not toxic to personnel under normal conditions of use.

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**TABLE 1080-1
PROPERTIES OF FOR RED PRIMER PAINT**

Property	Minimum	Maximum
Pigment % by Weight	53%	55%
Vehicle % by Weight	-	47%
Weight per Gallon	12.9 lb	-
Solids % by Volume	67.0%	-
Fineness of Grind Hegman Units	4.5	-
Moisture Content % by Weight	-	0.5
Skinning hrs (3/4 vol. in Closed Container)	48	-
Viscosity	85 KU	95 KU
Drying Time, Set to Touch	-	6 hrs
Drying Time, Dry Through	-	18 hrs
Adhesion ^A at 14 days (ASTM D3359)	3B	-
Volatile Organic Compounds per Gallon	-	2.8 lb

- 1 A. Prepare the specimen for the adhesion test by applying 2 dry mils of the coating
2 to a standard Q panel.

**TABLE 1080-2
COMPOSITION OF PIGMENTS FOR RED PRIMER PAINT, % BY WEIGHT**

Pigment	Minimum	Maximum
Zinc Hydroxy Phosphite	73%	-
Red Iron Oxide (86% Fe ₂ O ₃)	24%	-
Organo Montmorillonite	-	1%

**TABLE 1080-3
COMPOSITION OF VEHICLES FOR RED PRIMER PAINT, % BY WEIGHT**

Vehicle	Minimum	Maximum
Non-Volatile	62%	-
Alkyd Resin Solids Fed. Spec TT-4-266, Type 1, Class A	40%	-
Linseed Oil (ASTM D234)	20%	-
Linseed Oil to Alkyd Ratio	1.2%	-
Thinner and Dryer Thinner: Fed. Spec. TT-T291, Type 2 Gr. A Dryer: Fed. Spec. TT-D-643B	38%	-

3 **1080-6 ALKYD FINISH PAINT**

4 **(A) Scope**

5 This article covers a gray, long oil-alkyd primer paint for use over surfaces coated with
6 Red Alkyd Primer Paint. The paint may be applied by brushing or spraying to a wet film
7 thickness of approximately 3 wet mils per coat.

8 **(B) Materials**

9 Materials shall be as specified herein. Materials not specified will be selected by the
10 supplier and be subject to all of the requirements of this Specification. Use paint made of
11 materials which are not toxic to personnel under normal conditions of use.

**TABLE 1080-4
PROPERTIES OF ALKYD FINISH PAINT**

Property	Minimum	Maximum
Pigment % by Weight	47%	-
Vehicle % by Weight	-	54%
Weight per Gallon	11.0 lb	-
Solids % by Volume	54.0%	-
Fineness of Grind Hegman units	6.0	-
Moisture Content % by Weight	-	0.5
Skinning hrs (3/4 vol. in Closed Container)	48	-
Viscosity	90 KU	100 KU
Drying Time, Set to Touch	-	6 hrs
Drying Time, Dry Through	-	18 hrs
Adhesion ^A at 14 days (ASTM D3359)	3B	-
Volatile Organic Compounds per Gallon	-	3.5 lb
Lead Content % by Weight Dry Film	-	0.05%
Color (Federal Color Standard 595)	26622 (Gray)	-

- 1 **A.** Prepare the specimen for the adhesion test by applying 2 dry mils of the coating to a standard Q panel.
2

**TABLE 1080-5
COMPOSITION OF PIGMENTS FOR ALKYD FINISH PAINT,
% BY WEIGHT**

Pigment	Minimum	Maximum
Zinc Hydroxy Phosphite ASTM D4462	20%	-
Titanium Dioxide ASTM D476 TY-II	50%	-
Magnesium Silicate	15%	-
Tinting and Inert Pigments	-	12%

**TABLE 1080-6
COMPOSITION OF VEHICLES FOR ALKYD FINISH PAINT,
% BY WEIGHT**

Vehicle	Minimum
Non-Volatile	62%
Alkyd resin solids	40%
Fed. Spec TT-4-266, Type 1, Class A	
Linseed oil (ASTM D234)	20%
Linseed oil to Alkyd ratio	1.2%
Thinner and Dryer	38%
Thinner: Fed. Spec. TT-T291, Type 2 Gr. A	
Dryer: Fed. Spec. TT-D-643B	

3 **1080-7 SELF-CURING INORGANIC ZINC PAINT**

- 4 Use a self curing inorganic zinc paint meeting the Type I Inorganic Zinc Primer paint
5 specified in AASHTO M 300 and the following:
6 **(A)** Use mixed paint with zinc content of not less than 72% by mass of the total solids.
7 **(B)** The slip coefficient meets AASHTO M 253, Class B.
8 **(C)** The adhesion shall be no less than 400 psi in accordance with ASTM D4541.
9 **(D)** Cure the paint to meet the solvent rub requirements in ASTM D4752.
10 **(E)** Formulate the paint to produce a distinct contrast in color with the blast cleaned metal
11 surfaces and with the finish paint.

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1 **1080-8 COAL TAR EPOXY PAINT**

2 Use coal tar epoxy paint meeting SSPC-Paint 16.

3 **1080-9 ORGANIC-ZINC REPAIR PAINT**

4 Use organic-zinc repair paint meeting SSPC-Paint 20 Type II or Federal
5 Specification TT-P-641. Organic-zinc repair paint is not tinted and is applied 3 to 4 wet mils
6 of paint per coat. Do not use zinc paint in aerosol spray cans.

7 **1080-10 WASH PRIMER PAINT**

8 Use wash primer paint meeting SSPC-Paint 27.

9 **1080-11 WATERBORNE PAINTS**

10 **(A) Paints**

11 (1) Waterborne Primer Paints

12 The chemical requirements of the brown and white primer paints are specified in
13 Tables 1080-7 through 1080-10. Use primer paints on roughened steel surfaces
14 cleaned to an SSPC-SP 6 finish. Two coats of paint are required to form an effective
15 primer coat. The first coat is brown and the second is white. Each coat is applied at
16 a wet film thickness of approximately 6 mils.

17 (2) Waterborne Finish Paints

18 The chemical requirements of the gray and green finish paints are specified in
19 Tables 1080-11 through 1080-14. Apply finish paints over compatible primer paints.
20 Apply either one or 2 coats at a wet film thickness of approximately 6 mils each to
21 produce an effective finish coat.

22 **(B) Description**

23 The acrylic paints furnished in accordance with this Specification are one component
24 products made from acrylic resins with sufficient additives, coalescing agents, solvents
25 and pigmentation to produce a durable paint.

26 These products are intended for brush, roller or spray application applied in accordance
27 with SSPC-PA 1.

28 **(C) Composition**

29 Use ingredients and proportions as specified in Tables 1080-7 through 1080-14. Do not
30 use Chrome Green.

31 Provide raw materials based on the specified ingredients that are uniform, stable in
32 storage, and free from grit and coarse particles. Do not use rosin or rosin derivatives.
33 Beneficial additives such as anti-skinning agents, suspending agents or wetting aids are
34 allowed.

35 **(D) Properties**

36 (1) General

37 Use both Type I and II paints that meet Tables 1080-7 through 1080-14.

38 (2) Odor

39 Normal for the materials permitted in accordance with ASTM D1296.

- 1 (3) Color
- 2 (a) Waterborne Primer Paint
- 3 The color before and after weathering when compared with Federal Test Method
4 Standard No. 595B is Brown #30045 for Type I. There are no color
5 requirements for the white primer.
- 6 (b) Waterborne Finish Paint
- 7 The colors before and after weathering when compared with Federal Test
8 Method Standard No. 595B are Green #24108 for Type I and Gray #26622 for
9 Type II.
- 10 (4) Working Properties
- 11 Use a paint that is easily applied by brush, roller or spray when tested in accordance
12 with Federal Test Method Standard No. 141, Methods 4321, 4331 and 4541. Ensure
13 that the paint shows no streaking, running or sagging during application or while
14 drying.
- 15 (5) Condition In Container
- 16 Ensure that the paint shows no thickening, curdling, gelling or hard caking when
17 tested as specified in Federal Test Method Standard No. 141, Method 3011, after
18 storage for 6 months from the date of delivery, in a full, tightly covered container, at
19 a temperature of 50°F to 110°F.
- 20 (6) Skinning
- 21 No skinning is allowed in a 3-quarters filled closed container after 48 hours when
22 tested in the standard manner specified in Federal Test Method Standard No. 141,
23 Method 3021.
- 24 (7) Salt Contamination
- 25 Minimize the content of salt contamination by the incorporation of only high purity
26 materials. Ensure that the specific resistance of the aqueous leachate of the
27 composite of the pigments in required proportions is at least 5,000 ohm-cm when
28 tested in accordance with ASTM D2448.
- 29 (8) Early Rust Resistance
- 30 Provide each type of paint that meets the early rust requirements specified in
31 Materials and Tests Standards CLS-P-1.0.
- 32 (9) Directions For Use
- 33 Supply the following directions for use with each container of paint:
- 34 Waterborne primer paint is intended for use as a primer over rough, bare structural
35 steel. It is not intended for use over other paint systems. Waterborne finish paint is
36 intended for use as a topcoat over a compatible primer in atmospheric exposure. Mix
37 the paint thoroughly before use. For roller, brush or airless spray application, no
38 thinning should be necessary. A minimum amount of thinning may be necessary for
39 conventional air spray. Apply by brush or spray to the specified film thickness, or if
40 none is specified, to at least 2 mils dry or approximately 6 mils wet. Dry the surface
41 to be painted and ensure that the surface temperature is at least 5°F above the dew
42 point, the humidity is less than 85%, and the temperature of the air is over 50°F. Do
43 not paint outdoors in rainy weather or if freezing temperatures are expected before
44 the paint dries. Allow the paint at least 24 hours drying time before recoating.

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1 (E) Inspection

2 All materials supplied under this Specification are subject to random inspection by the
3 Department.

4 Supply samples of any or all ingredients used in the manufacture of this paint, along with
5 the supplier's name and identification for the material when requested.

6 (F) Volatile Organic Compound (VOC) Content

7 Ensure that the VOC content after formulation, but before thinning, complies with the
8 VOC limit for the applicable coatings category per Federal regulations. Notify the
9 coating specifier if State or local regulations reduce the maximum VOC content
10 permitted for coatings applied in a specific locality.

11 (G) Color Variation

12 A color variation of 5 Δe units from the specified color will be acceptable. After
13 3 months weathering, the color shall not vary more than 5 Δe units from the original color
14 value.

**TABLE 1080-7
COMPOSITION OF PIGMENTS FOR WATERBORNE PRIMER PAINTS,
% BY WEIGHT**

Characteristics	Minimum	Maximum	Test Method
<u>PIGMENT CONTENT:</u>			
Type I (Brown)	20%	25%	ASTM D3723
Type II (White)	35%	40%	ASTM D3723
<u>VOLATILES:</u>			
Type I (Brown)	-	2.0 lb/gal	ASTM D2369
Type II (White)	-	2.0 lb/gal	ASTM D2369
Coarse Particles and Skins, as Retained on Std. 325 Mesh Screen	-	0.5%	ASTM D185
Rosin or Rosin Derivatives	-	0	ASTM D1542

**TABLE 1080-8
COMPOSITION OF PIGMENTS FOR WATERBORNE PRIMER PAINTS,
% BY WEIGHT**

Pigments	Type I (Brown)		Type II (White)		Test Method
	Minimum	Maximum	Minimum	Maximum	
<u>MAJOR PIGMENTS:</u>					
Pigments	20%	25%	35%	40%	ASTM D3723
Calcium Carbonate	-	-	30%	-	ASTM D1159
Magnesium Silicate	-	-	-	12%	ASTM D605
Titanium Dioxide	-	-	45%	-	ASTM D476, Type II
Zinc Phosphate	10%	-	10%	-	NCDOT M&T P-10
Iron Oxide	45%	-	-	-	ASTM D3721
<u>TINTING PIGMENTS:</u>					
Lamp Black	-	-	2%	-	ASTM D209
Phthalocyanine Pigments	-	-	-	2%	ASTM D1135 and D3256
Acid Soluble Pigments ^A	-	-	-	0	-
Lead	-	0.005%	-	0.005%	-

1 A. Use a 5% acetic acid solution with a pH 4 + 2 to determine solubility.

**TABLE 1080-9
COMPOSITION OF VEHICLES FOR WATERBORNE PRIMER PAINTS,
% BY WEIGHT**

Vehicle	Type I (Brown)		Type II (White)		Test Methods
	Minimum	Maximum	Minimum	Maximum	
Total Vehicle	73%	80%	60%	65%	NCDOT M&T P-10
HG-56 ^A Solids	30%	-	30%	-	-
Water	-	55%	-	55%	-
Methyl Carbitol	5%	-	5%	-	-
Texanol	2%	-	2%	-	-

2 A. Or approved equivalent.

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TABLE 1080-10 PROPERTIES OF WATERBORNE PRIMER PAINTS			
Property	Minimum	Maximum	Test Method
Consistency ^A Shear Rate 200 rpm, Ounces	255	350	ASTM D562
Consistency ^A Shear Rate 200 rpm, Krebs units	3.2	3.5	ASTM D562
Density, lb/US gal, Type I (Brown)	9.7	-	ASTM D1475
Density, lb/US gal., Type II (White)	11.0	-	ASTM D1475
Fineness of Grind, Hegman Units	5.0	-	ASTM D1210
Drying Time, Hours, Tack Free	-	3	ASTM D1640
Drying Time, Hours, Dry Hard	-	24	ASTM D1640
Flash Point, °F	Report Value	Report Value	ASTM D3278
Early Rust	9	-	NCDOT M&T CLS-P-1.0
Leneta Sag Test	10+	-	-
Gloss, Specular @ 60°	Report Value	Report Value	-
pH	8.0	8.5	-
Adhesion ^B	4B	-	ASTM D3359
Color, Fed. Std. 595B, Type I (Brown)	30045	-	ASTM D2244
Color, Fed. Std. 595B, Type II (White)	NA	-	ASTM D2244

- 1 **A.** Consistency 48 hours or more after manufacture.
- 2 **B.** Prepare the specimen for adhesion by applying 2 dry mils of coating to
- 3 a 3" x 5" x 0.25" steel panel cleaned to a minimum SSPC-SP 6 finish with
- 4 a 1.7 + 0.5 mil profile.

Characteristics	Minimum	Maximum	Test Method
<u>PIGMENT CONTENT:</u>			
Type I (Green)	13%	17%	ASTM D3723
Type II (Gray)	13%	17%	ASTM D3723
<u>VOLATILE:</u>			
Type I (Green)	-	2.0 lb/gal	ASTM D2369
Type II (Gray)	-	2.0 lb/gal	ASTM D2369
Coarse Particles and Skins, as Retained on Std. 325 Mesh Screen	-	0.5%	ASTM D185
Rosin or Rosin Derivatives	-	0%	ASTM D1542-93

Pigment	Type I(Green)		Type II (Gray)		Test Method
	Minimum	Maximum	Minimum	Maximum	
<u>MAJOR PIGMENTS:</u>					
Pigments	13%	17%	13%	17%	ASTM D3723
Calcium Carbonate	-	-	-	-	ASTM D1159
Magnesium Silicate	-	-	-	-	ASTM D605
Titanium Dioxide	5%	-	70%	-	ASTM D476, Type II
Zinc Phosphate	10%	-	10%	-	NCDOT M&T P-10
<u>TINTING PIGMENTS:</u>					
Lamp Black	-	-	-	-	ASTM D209
Phthalocyanine Green	0%	-	0%	-	ASTM D3021
Red Iron Oxide	-	-	-	-	ASTM D3721
Yellow Iron Oxide	-	-	-	-	ASTM D768
Acid Soluble Pigments ^A	-	-	-	0%	-
Lead	-	0.005%	-	0.005%	-

1

A. Use a 5% acetic acid solution with a pH 4 + 2 to determine solubility.

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TABLE 1080-13 COMPOSITION OF VEHICLES FOR WATERBORNE FINISH PAINTS, % BY WEIGHT					
Vehicle	Type I	Green	Type II	Gray	Test Method
	Minimum	Maximum	Minimum	Maximum	
Total Vehicle	83%	87%	83%	87%	NCDOT M&T P-10
HG-56 ^A Solids	30%	-	30%	-	-
Water	-	58%	-	58%	-
Methyl Carbitol	5%	-	5%	-	-
Texanol	4%	-	4%	-	-

1 A. Or approved equivalent.

TABLE 1080-14 PROPERTIES OF WATERBORNE FINISH PAINTS			
Property	Minimum	Maximum	Test Methods
Consistency ^A Sheer Rate 200 rpm, Ounces	255	350	ASTM D562
Consistency ^A Sheer Rate 200 rpm, Krebs Units	90	100	ASTM D562
Density, lb/US gal, Type I (Brown)	9.35	-	ASTM D1475
Density, lb/US gal, Type II (White)	9.35	-	ASTM D1475
Fineness of Grind, Hegman Units	5.0	-	ASTM D1210
Drying Time, Hours, Tack Free	-	3	ASTM D1640
Drying Time, Hours, Dry Hard	-	24	ASTM D1640
Flash Point, °F	Report Value	Report Value	ASTM D3278
Early Rust	9	-	NCDOT M&T CLS-P-1.0
Leneta Sag Test	10+	-	-
Gloss, Specular @ 60°	40	-	-
pH	8.0	8.5	-
Adhesion ^B	4B	-	ASTM D3359
Color, Fed. Std. 595B, Type I (Green)	24108	-	ASTM D2244
Color, Fed. Std. 595B, Type IB (NC Green)	24272	-	ASTM D2244
Color, Fed. Std. 595B, Type II (Gray)	26622	-	ASTM D2244

2 A. Consistency 48 hours or more after manufacture.

3 B. Prepare the specimen for adhesion by applying 2 dry mils of coating to
4 a 3" x 5"x 0.25" steel panel cleaned to at least a SSPC-SP 6 finish with
5 a 1.7 + 0.5 mil profile.

1 **1080-12 PAINT FOR VERTICAL MARKERS**

2 For vertical markers, use a waterborne acrylic or alkyd type material meeting Table 1080-15.
 3 Apply sufficient paint to completely cover the color of the underlying substrate along with
 4 any surface imperfections.

TABLE 1080-15		
PROPERTIES OF PAINT FOR VERTICAL MARKERS		
Property	Requirement	Test Method
Color	# 27040 Black or # 13538	Federal Color Std. 595
Adhesion to Substrate	3A Min.	ASTM D3359

5 **1080-13 ABRASIVE MATERIALS FOR BLAST CLEANING STEEL**

6 Select the gradation of the abrasive to impart the anchor profile specified.

7 **(A) Expendable Abrasive**

8 Use blasting abrasives with a suitable steel or mineral abrasive containing no more than
 9 100 ppm of any corrosive compound such as sulfate or chloride or 100 ppm of any
 10 EPA characteristic waste compound such as lead, chromium or arsenic.

11 **(B) Recyclable Steel Grit**

12 Use abrasives that when sampled at any time during the blasting process, contain no more
 13 than 100 ppm of any corrosive compound such as sulfate or chloride or 1,000 ppm of any
 14 EPA characteristic waste compound such as lead, chromium or arsenic. Maintain the size
 15 and shape of the abrasive to impart the specified profile.

16 **1080-14 FIELD PERFORMANCE AND SERVICE**

17 Do not use paint products inspected by the Engineer and found to exhibit poor performance in
 18 similar North Carolina environments. Poor performance is defined as any coating failing to
 19 meet ASTM D610, Grade 5, or having greater than 3% rusting or disbonding before attaining
 20 5 years of service.

21 **SECTION 1081**
 22 **EPOXY AND ADHESIVES**

23 **1081-1 EPOXY RESIN SYSTEMS**24 **(A) Classification**

25 The types of epoxies and their uses are as shown below:

26 **Type 1** - A low-modulus, non-sag gel adhesive used to bond or repair damp, vertical or
 27 overhead surfaces. Typical applications include walls, concrete foundations, concrete
 28 pipe, conduit and ceilings.

29 **Type 2** - A low-modulus, general-purpose adhesive used in epoxy mortar repairs and
 30 broadcast sand sealing operations. Bridge Maintenance uses it as both a primer coat and
 31 thickness-building second coat in 2-stage sand broadcast operations to seal and skid-
 32 proof bridge decks. As a repair material, it may be used to patch spalled, cracked or
 33 broken concrete where vibration, shock or expansion and contraction is expected.
 34 Feather-edged patching is not recommended with this material; instead, the adjacent
 35 concrete perimeter should be sawed at least 1/4" to 1/2" deep and any remaining concrete
 36 chipped away to provide a vertical interface between the epoxy mortar and concrete.

37 **Type 3** - A high-modulus general-purpose adhesive used to bond plastic concrete or
 38 hardened concrete to hardened concrete or other structural materials. It may be used to
 39 produce a high-strength epoxy mortar grout bed for equipment or to patch interior spalls,
 40 cracks or broken concrete. It is not recommended for exterior patching because its rate of

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1 thermal expansion and contraction differs too greatly from concrete. It may be used for
2 anchoring bolts where a flowable adhesive is required.

3 **Type 3A** - A gel-like version of Type 3, used specifically for embedding dowel bars,
4 threaded rods, rebars and other fixtures in hardened concrete. The manufacturer shall
5 submit test results showing that the bonding system will obtain 125% of the specified
6 yield strength of the anchor fixture in concrete with a minimum compressive strength of
7 3,000 psi. Plans may call for field testing of adhesively anchored fixtures.

8 **Type 4A** - A gray protective coating for concrete, wood, steel and other structural
9 materials. It is typically used as a topcoat in waterproofing concrete exposed to splash
10 zones and tidal water.

11 **Type 4B** - A red primer coating used with Type 4A.

12 **Type 5** - A high modulus, low viscosity adhesive suitable for pressure injection into
13 cracks in concrete. For some non-structural crack repairs, Type 5 epoxy may be poured
14 on the surface to penetrate cracks by gravity. This may be beneficial before
15 waterproofing and skid proofing.

16 **Type 6A** - An adhesive for bonding raised traffic markers to concrete or asphalt surfaces.
17 Part A shall be pigmented white, Part B black so when the components are combined
18 a uniform gray color results.

19 **Type 6B** - A normal-setting self-leveling adhesive for bonding traffic markers in recessed
20 areas on concrete and asphalt. Type 6A color requirements apply.

21 **Type 6C** - A rapid-setting adhesive for bonding traffic markers to concrete and asphalt
22 surfaces. Type 6A color requirements apply.

23 (B) Requirements

24 Epoxies shall conform to the requirements shown in Table 1081-1 using the test methods
25 described in Article 1081-3.

26 For epoxy resin systems used for embedding dowel bars, threaded rods, rebar and other
27 fixtures in hardened concrete, the manufacturer shall submit test results showing that the
28 bonding system will obtain 125% of the specified yield strength of the anchor fixture in
29 concrete with a compressive strength of at least 3,000 psi. Plans may call for field-testing
30 of adhesively anchored fixtures.

31 (C) Properties of Epoxy Resin Systems

32 (1) All integral fillers, pigments and thixotropic agents shall be fine enough to not
33 separate, settle or cause skinning during storage of the epoxy components. Do not
34 use abrasive fillers such as alumina and silica flour. Do not use solvents. When
35 mineral fillers are to be added during mixing, they shall be inert, readily dispersible
36 and except for sand, have fineness such that 99% of the material will pass
37 a No. 325 sieve.

38 (2) The coefficient of expansion of cured epoxy is 6 times greater than that of concrete.
39 Therefore, to reduce spalling and peeling during temperature changes, avoid thick
40 layers of pure epoxy. A 4:1 by weight sand-epoxy mortar has approximately the
41 same coefficient of expansion as concrete.

42 (3) The shelf life of parts A and B shall be at least one year from the date of
43 manufacture.

44 (4) Types 1 through 5 epoxy resin systems are moisture insensitive and can be applied
45 on clean, dry or damp surfaces free of standing water.

**Table 1081-1
Properties of Mixed Epoxy Resin Systems**

Property	Type 1	Type 2	Type 3	Type 3A	Type 4A	Type 4B	Type 5	Type 6A	Type 6B	Type 6C
Viscosity-Poises at 77°F ± 2°F	Gel	10-30	25-75	Gel	40-150	40-150	1-6	1,500-3,000	400-800	1,500-3,000
Spindle No.	-	3	4	--	4	4	2	T-D	6	T-D
Speed (RPM)	-	20	20	--	10	10	50	5	10	5
Pot Life (Minutes)	20-50	30-60	20-50	5-50	40-80	40-80	20-60	8-13	8-13	7-10
Minimum Tensile Strength at 7 days (psi)	1,500	2,000	4,000	4,000	1,500	1,500	4,000	-	-	-
Tensile Elongation at 7 days (%)	30 min.	30 min.	2-5	2-5	5-15	5-15	2-5	-	-	-
Min. Compressive Strength of 2" mortar cubes at 24 hours	3,000 (Neat)	4,000-	6,000-	6,000 (Neat)	3,000	3,000	6,000	-	-	-
Min. Compressive Strength of 2" mortar cubes at 7 days	5,000 (Neat)	-	-	-	-	5,000	-	-	-	-
Maximum Water Absorption (%)	1.5	1.0	1.0	1.5	1.0	1.0	1.0	-	-	-
Min. Bond Strength Slant Shear Test at 14 days (psi)	1,500	1,500	2,000	2,000	1,500	1,500	1,500	-	-	□

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1 (D) Test Methods for Epoxies

2 (1) Viscosity

3 Determine the viscosity of the mixture in accordance with AASHTO T 237 using
4 Brookfield viscometer model RVT. Use the spindle number and speed shown in
5 Table 1081-1.

6 (2) Pot Life

7 Determine the pot life of the mixture in accordance with AASHTO T 237 except use
8 a mass of 60 ± 0.4 g.

9 (3) Compressive Strength of Epoxy Mortar

10 Determine the compressive strength of epoxy mortar in accordance with
11 ASTM C109 except as follows:

12 Use mortar consisting of one part epoxy and 3 parts standard graded Ottawa sand
13 except for Types 1 and 3A, which shall be tested neat. Mix epoxy
14 components A and B at the recommended proportions for 2 minutes, add the sand,
15 and mix for 3 minutes. Pour the mortar into the cube molds in 2 layers, and tamp
16 each layer 50 times with a spatula and 25 times with a hammer handle. Make
17 6 specimens, and cure all in air at $77^{\circ}\text{F} \pm 2^{\circ}\text{F}$ for 24 hours. Test 3 specimens for
18 compressive strength at the end of this curing period. Immerse the remaining
19 3 specimens in water at $+ 77^{\circ}\text{F}$ for 6 days, after which immediately test them for
20 compressive strength in the wet condition.

21 (4) Tensile Strength and Tensile Elongation

22 Determine the tensile strength and tensile elongation of the mixture in accordance
23 with ASTM D638.

24 (5) Absorption

25 Determine the water absorption of the mixture in accordance with ASTM D570.

26 (6) Bond Strength

27 Determine the bond strength of the moist-cured mixture at 14 days by the slant shear
28 test in accordance with ASTM C882.

29 (E) Prequalification

30 All epoxy resin systems shall be on the NCDOT Approved Products List before use.
31 Manufacturers choosing to supply material for Department jobs must submit an Epoxy
32 Submittal Form to the Materials and Tests Physical Testing Laboratory with the
33 following information for each type and brand name:

34 (1) Contact information, including name, address and telephone number of the
35 manufacturer,

36 (2) Brand/Trade name of the material,

37 (3) Type of the material in accordance with Article 1081-1,

38 (4) Technical data sheet stating at a minimum product description, yield, technical
39 information, mixing directions, finishing directions, curing, clean-up and
40 precautions/limitations,

41 (5) Material Safety Data Sheets,

1 (6) Certified test data showing the product meets AASHTO M 237, including evidence
2 that the testing laboratory is regularly inspected by the Cement and Concrete
3 Reference Laboratory (CCRL) of the National Institute of Standards Technology or
4 other approved reference laboratory, and

5 (7) A sample of the product for testing (4 injection tubes or 1/2 gallon of each
6 component is required for testing).

7 Products will remain on the NCDOT Approved Products List as long as the formulation
8 and manufacturing process remain unchanged, and the product performs as intended in
9 the field. The manufacturer is required to submit an annual letter to the Materials and
10 Tests Physical Testing Laboratory certifying the formulation and manufacturing process
11 have not changed.

12 (F) Acceptance

13 When materials on the NCDOT Approved Products List are furnished to a project, submit
14 to the Engineer a Type 1 material certification in accordance with Article 106-3 for each
15 lot or batch delivered.

16 When materials are furnished to the Bridge Maintenance Unit, the terms of acceptance
17 will be listed in the bid solicitation. The Engineer reserves the right to reject any epoxy
18 that does not perform adequately in the field.

19 (G) Supply

20 Supply epoxy resin in 2 components, labeled as “Component A - Contains Epoxy Resin”
21 and “Component B - Contains Curing Agent”, for combining immediately before use in
22 accordance with the manufacturer’s instructions. Mark each container with the
23 manufacturer’s name, NCDOT type, lot or batch number, quantity, date of manufacture,
24 shelf life or expiration date, color, mixing instructions, usable temperature range and
25 hazards or safety precautions.

26 Furnish the 2 components in separate non-reactive containers. Provide containers of such
27 size that the proportions of the final mix can be obtained by combining a single container
28 of one component with one or more whole containers of the other component.

29 (H) Notes on Use of Epoxies

30 (1) Safety

31 Epoxies can irritate the eyes, skin and respiratory tract. Therefore, wear chemical
32 splash goggles, chemically-resistant gloves and protective clothing and boots when
33 handling epoxies. Respiratory protection is usually not needed if epoxies are mixed
34 and applied in well-ventilated areas, but avoid prolonged breathing of vapors.
35 Follow all MSDS instructions for proper use of these materials.

36 (2) Mixing

37 Stir parts A and B individually until each component is homogeneous. Use
38 a separate stirrer for each component.

39 Combine parts A and B, either by weight or volume, as specified in the
40 manufacturer’s instructions. Stir the mixture vigorously, periodically scraping the
41 sides and bottom of the container. Small quantities of epoxy usually require 2 to
42 3 minutes to mix homogeneously; 5-gallon quantities can take up to 10 minutes of
43 mixing.

44 Temperature affects the viscosity and pot life of epoxies. Most laboratory tests are
45 conducted at 77°F. Higher temperatures render epoxies thinner and faster setting;
46 lower temperatures induce higher viscosities and longer pot lives.

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1 Add sand or other fillers to liquid epoxies only after parts A and B have been
2 thoroughly mixed. Stir in the sand or filler until all particles are completely coated.

3 (3) Storage and Substrate Temperature

4 Store epoxies at temperatures between 50°F and 90°F. Epoxy components exposed
5 to the extremes of this range or outside this range should be conditioned to 77°F
6 before mixing and blending. If heat is necessary, always use indirect methods such
7 as hot water, a heated room or a microwave oven to condition components.

8 When applying epoxy to a cold substrate, preheat the components approximately 1°F
9 above 77°F for every 2°F of substrate temperature below 77°F.

10 Seal previously opened containers to be airtight. Unsealed containers can absorb
11 moisture from the atmosphere, which can alter the chemical reaction of the mixture.

12 1081-2 POLYESTER RESIN EPOXY ADHESIVE

13 (A) General

14 Polyester resin is used specifically for embedding dowel bars, threaded rods, rebars and
15 other fixtures in hardened concrete.

16 Have the manufacturer submit test results showing that the bonding system will obtain
17 125% of the specified yield strength of the anchor fixture in concrete with a minimum
18 compressive strength of 3,000 psi. Field testing may be required for adhesively anchored
19 fixtures.

20 (B) Materials

21 Package components of the adhesive in containers of such size that one whole container
22 of each component is used in mixing one batch of adhesive. Use containers of such
23 design that all of the contents may be readily removed, and are well sealed to prevent
24 leakage. Furnish adhesive material that requires hand mixing in 2 separate containers
25 designated as Component A and Component B. A self-contained cartridge or capsule
26 will consist of 2 components which will be automatically mixed as they are dispensed, as
27 in the case of a cartridge, or drilled into, as in the case of a capsule.

28 Clearly label each container with the manufacturer's name; date of manufacture; batch
29 number; batch expiration date; all directions for use and such warning of precautions
30 concerning the contents as may be required by Federal or State laws and regulations.

31 (C) Mixing of Adhesive

32 Mix adhesive in conformance with the manufacturer's instructions.

33 1081-3 HOT BITUMEN

34 Mix the adhesive asphaltic material with the filler homogeneously.

35 (A) Physical Requirements

36 Supply materials meeting Tables 1081-2 or 1081-3 and 1081-4.

Property	Min.	Max.	Test Method
Softening point, °F.	200	-	ASTM D36
Penetration, 100 g, 5 sec., 77°F	10	18	ASTM D5
Flow, inch, as modified in Subarticle 1081-4(B)	-	0.2	ASTM D5329
Viscosity, 400°F, poises or ASTM D4402 as modified in Subarticle 1081-4(B)	30	75	ASTM D2669
Flash Point, C.O.C., °F.	550	-	ASTM D92

**TABLE 1081-17
ASPHALT PROPERTIES OF ASPHALTIC MATERIAL
WITHOUT FILLER**

Property	Min.	Max.	Test Method
Penetration, 100 g, 5 sec., 77°F	25	-	ASTM D5
Viscosity, 275°F poises	12	100	ASTM D2171
Viscosity Ratio, 275°F	-	2.2	See Subarticle 1081-3(B)

**TABLE 1081-18
FILLER PROPERTIES**

Property	Min.	Max.	Test Method
Filler Content, % by Weight	65%	75%	See Subarticle 1081- 3(B)
Filler Fineness, % Passing No. 325	75%	-	ASTM C430 as modified in Subarticle 1081-3(B)
Filler Fineness, % Passing No. 200	95%	-	
Filler Fineness, % Passing No. 100	100%	-	

(B) Test Methods

(1) Flow

Determine flow according to Section 6 of ASTM D5329 with the exception that the oven temperature shall be 158°F ± 2°F and sample preparation done according to Section 7.1 of ASTM D5.

(2) Viscosity

Viscosity is to be determined according to ASTM D2669 or ASTM D4402 using a spindle speed of 10 rpm. Heat the adhesive to approximately 410°F and allowed to cool. Determine viscosity at 400°F ± 1°F.

(3) Asphalt Properties

Properties of the base asphalt are to be determined on the material obtained from the following extraction and Abson recovery methods. Extract the asphalt by heating the adhesive just to the point where it will easily flow and then transfer 125 to 150 g into 400 ml of trichloroethylene with a temperature of 125°F to 150°F. Thoroughly stir this mixture to dissolve the asphalt. Decant the trichloroethylene-asphalt mixture decanted and the asphalt recovered using the Abson recovery method, ASTM D1856 as modified by the following. The extraction methods of ASTM D2172 do not apply and there will be no filtration of the solvent asphalt mixture. The extraction solution of trichloroethylene and asphalt shall be centrifuged for at least 30 minutes at 770 times gravity in a batch centrifuge. Decant this solution in the distillation flask, taking care not to include any filler sediment. Apply heat and bubble carbon dioxide solution slowly to bring the solution temperature to 300°F. At this point the carbon dioxide flow is increased to 800 ml to 900 ml per minute. The solution temperature is maintained at 320°F to 335°F with this carbon dioxide flow for at least 20 minutes and until the trichloroethylene vapors have been completely removed from the distillation flask. Repeat the above extraction-recovery method as necessary to obtain the desired quantity of asphalt. Use the asphalt recovered to determine penetration, 275°F viscosity, and 275°F viscosity ratio.

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(4) Viscosity Ratio

Determine the 275°F viscosity ratio by comparing the 275°F viscosity on the base asphalt before and after the thin-film oven test. Perform the thin-film oven test in accordance with ASTM D1754. Determine the specific gravity by pycnometer as in ASTM D70 for use in the thin-film oven test. Calculate the 275°F viscosity ratio by dividing the viscosity after the thin-film oven test by the original 275°F viscosity.

(5) Filler Material

Separate the filler material from the asphalt to determine Filler Content and Filler Fineness. Determine the portion by weight of the adhesive insoluble in 1,1,1 trichloroethane by weighing 10.00 ± 0.01 grams of solid adhesive into a centrifuge flask with approximately 100 ml volume such as that specified in ASTM D1796. Add 50 ml of 1,1,1-trichloroethane to the adhesive, which should be broken up in small pieces to speed up the dissolution solids. Place the sample flask in a balanced centrifuge and spin using a minimum relative centrifugal force of 150 in accordance with ASTM D1796 for 10 minutes. Remove the sample flask and decant the solid, taking care not to lose any solids. Repeat the application of solvent and centrifuging until the solvent becomes clear and the filler is visually free of asphalt. Dry the filler at $160^{\circ}\text{F} \pm 5^{\circ}\text{F}$ to remove solvent and weigh the resulting filler. Filtration of the decanted solvent may be performed to verify there is no loss of filler. Percent filler content is calculated as follows:

$$\text{Filter Content, \% by Weight} = \frac{\text{Filler Weight, grams} \times 100}{\text{Original Adhesive Weight, grams}}$$

Determine Filler Fineness according to ASTM C430 using number 325, 200 and 100 sieves. This method is to be modified by using a water soluble non-ionic wetting agent, such as Triton X-100, to aid the wetting action. Concentration of the surfactant solution shall be approximately 1% by weight. Thoroughly wet the one-gram dry sample in the surfactant solution and allowed to soak for 30 minutes. Transfer the filler completely into the sieve cup and apply water spray for 2 minutes. Surfactant solution may be added as needed and physical means used to disperse any clumped particles. Dry the sample and handle as described in ASTM C430.

(C) Prequalification

Bituminous adhesives are required to be pre-qualified by the Department's Transportation-Traffic Engineering Branch. Interested parties shall submit a sample to a qualified independent testing laboratory for testing in accordance with Subarticle 1081-3(A) at no cost to the Department. Submit a Type 2 materials certification in accordance with Article 106-3 with the results and the name of the testing laboratory along with a qualification sample(s) of the same lot to the Department for evaluation. For more information on the pre-qualification process, contact the Work Zone Traffic Control Unit.

(D) Packaging and Labeling

Pack the adhesive in self-releasing cardboard containers which will stack properly. Containers shall have a net weight of 50 lb to 60 lb and contain 2 to 4 subcompartments. Ensure the label shows the manufacturer, quantity and batch number. Print "Bituminous Adhesive for Pavement Markers" or similar wording on the label.

(E) Certification

A certification from the manufacturer showing the physical properties of the bituminous adhesive and conformance with the Specifications shall be required before use.

(F) Application

Apply the adhesive according to the manufacturer's requirements and the following requirements.

Apply the adhesive when the road surface, ambient air and pavement marker temperatures are in the range of 50°F to 160°F on dry pavement.

The composition of the adhesive shall be such that its properties will not deteriorate when heated to and applied at temperatures up to 425°F using either air or oil-jacketed melters.

Melt and heat the bituminous adhesive in either thermostatically controlled double boiler type units using heat transfer oil or thermostatically controlled electric heating pots. Do not use direct flame units.

Heat the adhesive to between 375°F and 425°F and applied directly to the pavement surface from the melter/applicator by either pumping or pouring. Maintain the application temperature between 375°F and 425°F as lower temperatures may result in decreased adhesion while higher temperatures may damage the adhesive.

Use sufficient adhesive to insure total contact with the entire bottom of the pavement marker. Apply pavement markers to the adhesive immediately (within 5 seconds) to assure bonding. Place the pavement marker in position by applying downward pressure until the marker is firmly seated with the required adhesive thickness and squeeze-out. Remove excessive adhesive squeeze-out from the pavement and immediately remove adhesive on the exposed surfaces of pavement markers. Soft rags with mineral spirits conforming to Federal Specifications TT-T-291 or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent may be used.

Do not waste or spill any excess adhesive on Department right of way. Remove and properly dispose of any adhesive spilled or dumped at such location. The Contractor, at no cost to the Department, shall correct any damage incurred to the Department, highway or appurtenances as a result of misplaced adhesive.

The adhesive may be reheated and reused. However, the pot life at application temperatures shall not exceed the manufacturer's recommendations.

Clean out of equipment and tanks may be performed using petroleum solvents such as diesel fuel or similar materials. All solvents shall be removed from the equipment tanks and lines before the next use of the melter.

(G) Anchor Bolt Adhesives

Before application, test the adhesive for a tensile strength of 125% of the specified required yield load (42 kips) of the anchor bolt. Furnish certification that, for the particular bolt grade, diameter and embedment depth required, the anchor system will not fail by adhesive failure and that there is no movement of the anchor bolt. For certification and anchorage, use 3,000 psi as the minimum Portland cement concrete compressive strength used in this test.

Use adhesives that meet Section 1081.

List the properties of the adhesive on the container and include density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength.

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1 Package components of the adhesive in containers of such size that one whole container
2 of each component is used in mixing one batch of adhesive. Design the containers to
3 allow for all of the contents to be readily removed and be well sealed to prevent leakage.
4 Furnish adhesive material that requires hand mixing in 2 separate containers marked as
5 Component A and Component B. A self contained cartridge or capsule consists of
6 2 components that will automatically be mixed as they are dispensed.

7 Clearly label each container with the manufacturer's name, date of manufacture, batch
8 number, batch expiration date, all directions for use and such warning of precautions
9 concerning the contents as required by Federal or State laws and regulations.

SECTION 1082 STRUCTURAL TIMBER AND LUMBER

1082-1 GENERAL

13 Use Southern Pine timber and lumber graded in accordance with the current grading rules of
14 the Southern Pine Inspection Bureau unless otherwise specified or approved by the Engineer.
15 Use stress rated grades equal to or higher than the grades specified. For temporary crossings,
16 the use of stress rated lumber having stress ratings below those specified may be used if
17 approved by the Engineer.

18 Have all timber and lumber, including any preservative treatment, inspected and/or tested at
19 no cost to the Department by an approved commercial inspection company before it is
20 delivered to the project. Provide industry standard commercial inspection reports for each
21 shipment of untreated timber or lumber before its use on the project. Provide industry
22 standard commercial inspection reports and treatment test reports for each shipment of treated
23 timber or lumber before its use on the project. Perform all timber and lumber treatment
24 inspections in accordance with Standard M2 (Part A) of the AWPA Specifications. In
25 addition, brand, hammer mark, ink stamp or tag each piece of timber or lumber with the
26 approved commercial inspection company's unique mark to indicate it has been inspected.

1082-2 UNTREATED TIMBER AND LUMBER

28 Lumber that is 2" to 4" thick and 2" to 4" wide shall conform to Structural Light Framing,
29 Grade No. 1 Dense MC19. Lumber that is 2" to 4" thick and 6" wide or wider shall conform
30 to Structural Joists and Planks, Grade No. 1 Dense MC19. Lumber that is 5" and thicker
31 along the least dimension shall conform to Structural Lumber, Grade Dense Structural 72.
32 Rough lumber will be acceptable except where surfacing is called for by the contract. Rough
33 lumber may vary $\pm 1/4$ " from the dimensions shown on the contract or bill of material.

1082-3 TREATED TIMBER AND LUMBER

(A) General

36 Grade marked lumber will not be required. Brand or ink stamp each piece of treated
37 lumber in accordance with the AWPA Standard M6.

(B) Bridges, Fender Systems and Piles

39 Lumber for bridges that is 2" to 4" thick and 2" to 4" wide shall conform to Structural
40 Light Framing, Grade No. 1 Dense. Lumber for bridges that is 2" to 4" thick and 6" wide
41 and wider shall conform to Structural Joists and Planks, Grade No. 1 Dense. Lumber for
42 bridges that is 5" and thicker along the least dimension shall conform to Structural
43 Lumber, Grade Dense Structural 65. Lumber for fender systems shall conform to
44 Structural Lumber, Grade Dense Structural 65.

45 Timber for piles shall meet **ASTM D25** except that the timber shall be Southern Pine, and
46 have at least a 2" sap ring or a 3" sap ring where called for by the contract or where the
47 preservative is creosote and the retention is greater than 18 lb/cf.

1 Rough lumber will be acceptable except where surfacing is called for by the contract or
 2 bills of material. Rough lumber may vary $\pm 1/4$ " from the dimensions shown in the plans
 3 or bill of material. Dressed lumber may be $1/8$ " scant from the dimensions shown in the
 4 plans or bill of material. A $1/4$ " tolerance in length will be permitted.

5 **(C) Guardrail Posts**

6 Lumber for guardrail posts shall conform to Timbers, Grade No.1. Rough lumber will be
 7 acceptable. An allowable tolerance of $3/8$ " scant will be permitted from nominal
 8 dimensions.

9 **(D) Fence Posts and Braces**

10 Sawed fence posts and braces no larger than 4" x 4" shall conform to Structural Light
 11 Framing, Grade No. 2. Sawed fence posts and braces larger than 4" x 4" shall conform to
 12 Timbers, Grade No. 1.

13 Round lumber shall meet Subarticle 1050-2(A).

14 Use fully dressed S4S lumber for fence posts.

15 An allowable tolerance of $1/2$ " scant will be permitted from nominal dimensions of
 16 sawed and dressed lumber.

17 **(E) Sign Posts and Battens**

18 Lumber for sign posts no larger than 4" x 4" shall conform to Structural Light Framing,
 19 Grade No. 1 MC19. Lumber for sign posts larger than 4" x 4" and lumber for sign
 20 battens shall conform to Timbers, Grade No. 1. Use fully dressed S4S lumber for sign
 21 posts and battens.

22 An allowable tolerance of $1/2$ " scant will be permitted from nominal dimensions of sign
 23 posts. A tolerance of 1" under and 3" over will be permitted in the length of the post.

24 **(F) Poles**

25 Timber for poles shall meet ANSI O5.1 except the timber shall be treated Southern Pine
 26 or treated Douglas Fir. Use 40 ft Class 3 poles unless otherwise specified in the contract.

27 **1082-4 PRESERVATIVE TREATMENT**

28 **(A) General**

29 Give all timber and lumber required to be treated a preservative treatment in accordance
 30 with AWPAs Standards. The required retention of chromated copper arsenate is specified
 31 on the oxide basis. Preservative retention will be determined by the assay method.

32 After treatment, handle the timber and lumber carefully with rope slings, without sudden
 33 dropping, breaking of the fibers, bruising or penetrating the surface with tools or hooks.

34 Treated timber and lumber will not be accepted for use unless it has been inspected and
 35 found satisfactory, both before and after treatment, and shall be delivered to the project
 36 site in a condition acceptable to the Engineer.

37 Use treating plants that have laboratory facilities at the plant site for use of the inspector
 38 in accordance with AWPAs Standard T1.

39 **(B) Timber Preservatives**

40 Use timber preservatives conforming to AWPAs Standard T1.

41 **(C) Bridges, Fender Systems and Piles**

42 Treat timber and lumber for bridges and fender systems in accordance with
 43 AWPAs Standard U1, except the type of preservative and the retention of preservative will
 44 be as required by the contract.

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1 Treat piles in accordance to AWPA Standard U1, except the type of preservative and the
2 retention of preservative will be as required by the contract.

3 **(D) Guardrail Posts**

4 Treat guardrail posts in accordance to AWPA Standard U1, except require retention of
5 preservative as below.

6 Give all guardrail posts a preservative treatment of creosote, pentachlorophenol or
7 chromated copper arsenate. The same type of preservative is to be used throughout the
8 entire length of the project.

9 Minimum retention for creosoted timber will be 12 lb of preservative per cubic foot of
10 wood. Minimum retention for timber treated with pentachlorophenol will be 0.6 lb of dry
11 chemical per cubic foot of wood. Minimum retention for timber treated with chromated
12 copper arsenate will be 0.6 lb of dry chemical per cubic foot of wood.

13 **(E) Fence Posts and Braces**

14 Treat sawed posts and braces in accordance with AWPA Standard U1, except require
15 retention of preservative as below.

16 Treat round posts and braces in accordance with AWPA Standard U1, except require
17 retention of preservative as below.

18 Before treatment, peel round posts and braces cleanly for their full length, remove all
19 bark and innerskin, and trim all knots and projections flush with the surface of the
20 surrounding wood. Machine peeling will be permitted. Cut the ends to the proper length
21 before treatment.

22 Give all fence posts and braces a preservative treatment of either creosote,
23 pentachlorophenol, or chromated copper arsenate. The same type of preservative shall be
24 used throughout the entire length of the project.

25 Minimum retention for creosoted sawed timber will be 10 lb of preservative per cubic
26 foot of wood. Minimum retention for sawed timber treated with pentachlorophenol will
27 be 0.5 lb of dry chemical per cubic foot of wood. Minimum retention for sawed timber
28 treated with chromated copper arsenate will be 0.5 lb of dry chemical per cubic foot of
29 wood.

30 Minimum retention for creosoted round timber will be 8 lb of preservative per cubic foot
31 of wood. Minimum retention for round timber treated with pentachlorophenol will be
32 0.4 lb of dry chemical per cubic foot of wood. Minimum retention for round timber
33 treated with chromated copper arsenate will be 0.4 lb of dry chemical per cubic foot of
34 wood.

35 **(F) Sign Posts and Battens**

36 Treat sign posts and battens in accordance with AWPA Standard U1, except require
37 retention of preservative as below.

38 Give all sign posts and battens a preservative treatment of either pentachlorophenol or
39 chromated copper arsenate. The same type of preservative shall be used throughout the
40 entire length of the project.

41 Minimum retention for timber treated with pentachlorophenol will be 0.6 lb of dry
42 chemical per cubic foot of wood. Minimum retention for timber treated with chromated
43 copper arsenate will be 0.6 lb of dry chemical per cubic foot of wood.

44 All timber shall have moisture content of not greater than 19% before treatment. Redry
45 timber treated with chromated copper arsenate after treatment until it has moisture
46 content of not greater than 25%.

(G) Poles

Treat poles in accordance with AWWA Standard U1, except require retention of preservative as below.

Give all poles a preservative treatment of either pentachlorophenol, or chromated copper arsenate. The same type of preservative shall be used throughout the entire length of the project.

Minimum retention for poles treated with pentachlorophenol will be 0.45 lb by assay of dry chemical per cubic foot of wood. Minimum retention for poles treated with chromated copper arsenate will be 0.6 lb by assay of dry chemical per cubic foot of wood.

SECTION 1084 PILES

1084-1 PILES**(A) Treated Timber Piles**

Timber for treated timber piles shall meet Article 1082-3. Give treated timber piles a preservative treatment in accordance with Article 1082-4.

(B) Steel Piles

See Section 1076 for galvanized steel piles. Before incorporating steel piles into the work, obtain all applicable certified mill test reports clearly identifiable to the lot of material by heat numbers, submit these reports to the Engineer for review and analysis and receive approval of such test reports from the Engineer. These requirements apply to both domestic and foreign produced steel piles. Transfer the heat number of each painted pile to the newly painted surface with a permanent marker of a color contrasting to the paint once the paint has fully cured.

(1) Steel H-Piles

Steel H-piles shall meet ASTM A572 Grade 50 or ASTM A588.

(2) Steel Pipe Piles

Steel pipe piles shall be of uniform diameter and conform to ASTM A252 Grade 3 modified (50,000 psi). Make all joints and seams in the pipe pile watertight. Unless otherwise indicated by the contract, the ends of pipe pile may be flame cut. Square flame cut ends with axis of the pile to provide a full uniform bearing over the entire end area when the pile is being driven. Pipe piles under 24" in diameter shall be spliced by a certified pipe welder.

(C) Prestressed Concrete Piles

Prestressed concrete piles shall meet Section 1078.

1084-2 STEEL SHEET PILES

Steel sheet piles detailed for permanent applications shall be hot rolled and meet ASTM A690 unless otherwise required by the plans.

Steel sheet piles detailed for temporary applications shall be hot rolled and meet ASTM A328.

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**SECTION 1086
PAVEMENT MARKERS**

1086-1 TEMPORARY RAISED PAVEMENT MARKERS

(A) General

Use raised pavement markers evaluated by NTPEP.

Use raised pavement markers of the prismatic reflector type, or better as approved. The markers shall be constructed either of an injection molded plastic body and base or consist of a plastic shell filled with a mixture of inert thermosetting compound and filler material. Either construction type shall contain one or more integrated prismatic reflective lenses to provide the required color designation.

The minimum reflective area of the lens face is 2.0 sq.in.

The color of the reflective pavement marker housing shall match the pavement marking color, which it supplements.

All raised pavement marker reflective lenses shall be in close conformance with the Federal Standard No. 595 colors as listed below when viewed at night.

Crystal: Color No. 17886 (White)

Yellow: Color No. 13538

Red: Color No. 11302

(B) Adhesives

(1) Epoxy

The epoxy shall meet Section 1081.

The 2 types of epoxy adhesive which may be used are Type 6A, Standard Setting, and Type 6C, Rapid Setting. Use Type 6A when the pavement temperature is above 60°F. Use Type 6C when the pavement temperature is between 50°F and 60°F or when a fast set is desirable. Epoxy adhesive Type 6C, Cold Set, may be used to attach temporary pavement markers to the pavement surface when the pavement temperature is between 32°F and 50°F.

(2) Hot Bitumen

The hot bitumen shall meet Article 1081-3.

(3) Pressure Sensitive

As supplied by the manufacturer.

(C) Material Certification

Furnish a Type 2 material certification in accordance with Article 106-3 for all raised pavement markers before use.

1086-2 PERMANENT RAISED PAVEMENT MARKERS

(A) General

Use raised pavement markers evaluated by NTPEP. The markers shall be constructed either of an injection molded plastic body and base or consist of a plastic shell filled with a mixture of inert thermosetting compound and filler material. Either construction type shall contain one or more integrated prismatic reflective lenses to provide the required color designation. Raised pavement markers (permanent) shall be of the glass or plastic face lens type and meet Subarticle 1086-1(A). Plastic lenses shall have an abrasion resistant coating.

1 (1) Potted Markers

2 Potted marker shells shall be made of molded methyl methacrylate conforming to
 3 Federal Specification L P 380C, Type I, Class 3. Filling material shall be an inert
 4 thermosetting compound selected for strength, resilience, and adhesion adequate to
 5 meet physical requirements of the *Standard Specifications*. Sand or other inert
 6 granulars shall be embedded in the surface of the inert thermosetting compound and
 7 filler material before its curing to provide a surface, which will readily bond to the
 8 adhesive.

9 (2) Injection-molded Markers

10 Injection-molded markers shall consist of polymer materials selected for strength and
 11 resilience adequate to meet the physical requirements of the *Standard Specifications*.
 12 The bottom surface of the marker shall contain grooves or nonsmooth structure
 13 designed to increase bonding with the adhesive.

14 **(B) Optical Requirements**

15 All optical performance for permanent raised pavement markers shall conform to
 16 ASTM D4280.

17 **(C) Physical Properties**

18 All physical properties for permanent raised pavement markers shall conform to
 19 ASTM D4280.

20 **(D) Hot Bitumen Adhesives**

21 Use hot bitumen adhesive for mounting the pavement markers to asphalt concrete
 22 roadways. The hot bitumen adhesive shall meet the requirements of Article 1081-3.
 23 Other adhesives such as epoxy or cold bituminous adhesive pads are not acceptable on
 24 asphalt concrete roadways for permanent applications.

25 **(E) Epoxy Adhesives**

26 Use epoxy adhesive for mounting the pavement markers to concrete roadways. The
 27 epoxy adhesive shall comply with Section 1081. Other adhesives such as hot and cold
 28 bituminous or adhesive pads are not acceptable on concrete roadways for permanent
 29 applications.

30 **(F) Material Certification**

31 Furnish a Type 2 material certification in accordance with Article 106-3 for all raised
 32 pavement markers before use.

33 **1086-3 SNOWPLOWABLE PAVEMENT MARKERS**34 **(A) General**

35 Use snowplowable pavement markers evaluated by NTPEP. The snowplowable
 36 pavement marker shall consist of a cast iron housing with one or more glass or plastic
 37 face lens type reflective lenses to provide the required color designation. Shape the
 38 casting to deflect a snowplow blade upward in both directions without being damaged.
 39 Incorporate into the casting 2 parallel keels and a connecting web designed to fit into
 40 slots cut into the road surface. Plastic lens faces shall use an abrasion resistant coating.

41 Use recycled snowplowable pavement markers that meet all the requirements of
 42 new snowplowable pavement markers except Subarticle 1086-3(B)(1). Recycled
 43 snowplowable pavement markers with minimal variation in dimensions are acceptable
 44 only when the reflector fits in the casting of the recycled snowplowable pavement marker
 45 as originally designed.

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1 (B) Castings

2 (1) Dimensions

3 The dimension, slope and minimum area of reflecting surface shall conform to
4 dimensions as shown in the plans. The minimum area of each reflecting surface
5 shall be 1.44 sq.in.

6 (2) Materials

7 Use nodular iron in accordance with ASTM A536.

8 (3) Surface

9 The surface of the keel and web shall be free of scale, dirt, rust, oil, grease or any
10 other contaminant which might reduce its bond to the epoxy adhesive.

11 (4) Identification

12 Mark the casting with the manufacturer's name and model number of marker.

13 (C) Reflectors

14 (1) General

15 Laminate the reflector to an elastomeric pad and attach with adhesive to the casting.
16 The thickness of the elastomeric pad shall be 0.04".

17 (2) Reflector Type

- 18 (a) One-direction, one color (crystal)
- 19 (b) Bidirectional, one color (yellow and yellow)
- 20 (c) Bidirectional, two colors (red and crystal)
- 21 (d) Bidirectional, two colors (red and yellow)

22 All pavement marker reflective lenses shall be in close conformance with the Federal
23 Standard No. 595 colors as listed below when viewed during night situations.

Crystal: Color No. 17886 (White)

Yellow: Color No. 13538

Red: Color No. 11302

24 (3) Reflector Optical Requirements

25 (a) Definitions

26 Define "horizontal entrance angle" as the angle in the horizontal plane between
27 the direction of incident light and the normal to the leading edge of the marker.

28 Define "observation angle" as the angle, at the reflector, between observer's line
29 of sight and the direction of the light incident on the reflector.

30 Define "specific intensity (S.I.)" as candlepower of the returned light at the
31 chosen observation and entrance angles for each footcandle of illumination at
32 the reflector.

$$\mathbf{S.I.} = \mathbf{RL} \times (\mathbf{D} \times \mathbf{D}) \times \mathbf{IL}$$

Where:

S.I. = Specific Intensity

RL = Reflected Light

IL = Incident Light

D = Test Distance

(b) Optical Performance

Test the reflector for specific intensity as described below:

Form a 1" diameter flat pad using #3 coarse steel wool per Federal Specification FF-W-1825. Place the steel wool pad on the reflector lens. Apply a load of 50 lb and rub the entire lens surface 100 times. Do not abrade the red lens of the Type 3 and Type 4 bi-directional units.

Locate the reflector to be tested with the center of the reflecting face at a distance of 5 ft from a uniformly bright light source having an effective diameter of 0.2".

The photocell must be an angular ring 0.37" I.D. x 0.47" O.D. Shield it to eliminate stray light. The distance from light source center to the center of the photoactive area shall be 0.2". If a test distance of other than 5 ft is used, modify the source and receiver in the same proportion as the test distance.

After abrading the lens surface using the above steel wool abrasion procedure, the specific intensity of each crystal reflecting surface at 0.2 degrees observation angle must not be less than the following when the incident light is parallel to the base of the reflector.

Color	Horizontal Entrance Angle	
	0 Degrees	20 Degrees
Crystal	3.00	1.20
Yellow	1.80	0.72
Red	0.75	0.30

(D) Properties

All optical and physical properties for snowplowable pavement markers shall conform to ASTM D4383.

(E) Epoxy Adhesive

The epoxy adhesive shall meet the requirements of Section 1081. Mix the epoxy adhesive rapidly by a 2 component type automatic metering, mixing and extrusion apparatus.

(F) Material Certification

Furnish a Type 2 material certification in accordance with Article 106-3 for all raised snowplowable markers before use.

SECTION 1087 PAVEMENT MARKINGS

1087-1 GENERAL

Yellow and white pavement markings shall be retroreflective. Black pavement markings shall be matte, non-retroreflective.

The material manufacturer has the option of formulating the pavement marking material according to his own specifications; however, the manufacturer shall meet all the minimum requirements specified herein.

All pavement marking materials, pigments, beads and resins shall be free from all skins, dirt and foreign objects.

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1 Use pavement marking materials capable of being fabricated into pavement markings of
2 specified dimensions and adhering to asphalt and Portland cement concrete pavements when
3 applied in accordance with their manufacturer's recommendation.

4 Pavement marking materials upon heating shall not exude fumes, which are toxic, or injurious
5 to persons or property.

6 Homogeneously mix all pavement marking materials.

7 **1087-2 COMPOSITION**

8 **(A) Paint Composition**

9 Pavement marking paint shall be a ready mixed type paint product conforming to Federal
10 Specification FP03 with spraying consistency suitable for use as a retroreflective
11 pavement marking. Glass beads are dropped by suitable pressurized means into the wet
12 paint as it is applied to the pavement.

13 **(B) Removable Tape Composition**

14 Removable tape pavement marking shall be composed of materials as specified by their
15 manufacturer.

16 Use removable tape markings capable of conforming to pavement contours, breaks,
17 faults, etc. through the action of traffic at normal pavement temperatures. The tape shall
18 have resealing characteristics such that it is capable of fusing with itself and previously
19 applied marking tape of the same composition under normal conditions of use. The
20 removable tape markings shall be patchable.

21 Use removable tape markings capable of adhering to the pavement by
22 a pressure-sensitive pre-coated adhesive or as directed by the manufacturer.

23 **(C) Thermoplastic Composition**

24 Use thermoplastic alkyd/maleic pavement markings composed of the materials in
25 Table 1087-1.

TABLE 1087-1 PHYSICAL PROPERTIES OF THERMOPLASTIC ALKYD/MALEIC PAVEMENT MARKINGS	
Component	By Weight
Alkyd/Maleic Binder	18.0% Min
Glass Beads (Premixed)	30.0% Min
Titanium Dioxide Pigment (ASTM D476 Type 2)	10.0% Min.
Yellow Pigment (For Yellow Marking Only) Silica Encapsulated Lead Chromate Pigment	4.0% Min.

26 Use white thermoplastic that does not contain anatase titanium dioxide pigment.

27 Provide yellow thermoplastic that contains only heat resistant silica encapsulated lead
28 chromate pigment. The lead chromate pigment shall contain at least 60% lead chromate.

29 Calcium carbonate and inert fillers may be as opted by the manufacturer, providing all
30 other qualifications are met.

31 The total silica content used in the formulation of the thermoplastic shall be the premixed
32 glass beads. Uniformly disperse the pigment, beads, and filler in the binder.

1 The Alkyd/maleic binder shall consist of a mixture of synthetic resins (at least one
 2 synthetic resin shall be solid at room temperature) and a high boiling point plasticizers.
 3 At least 1/2 of the binder composition shall be 100% maleic-modified glycerol of resin
 4 and be no less than 15% by weight of the entire material formulation. The binder shall
 5 contain no petroleum hydrocarbon resins. Use resins/rosins that are maleic-modified
 6 glycerol esters.

7 The thermoplastic material shall be free of contaminates and be homogeneously dry-
 8 blended or hot mixed from 100% virgin stock using no reprocessed materials, (excluding
 9 the requirement to use reprocessed glass).

10 The thermoplastic material shall not deteriorate or discolor when held at the application
 11 temperatures for at least 4 hours or upon repeated reheating (at least 4 times).

12 The color, viscosity and chemical properties versus temperature characteristics of the
 13 thermoplastic material shall remain constant for up to 4 hours at the application
 14 temperature and be the same from batch to batch.

15 The thermoplastic material shall be readily applicable at temperatures between 400°F and
 16 440°F from the approved equipment to produce lines and symbols of the required above
 17 the pavement thickness.

18 **(D) Cold Applied Plastic Composition**

19 The cold applied plastic pavement marking shall consist of a mixture of high quality
 20 polymeric materials, pigments and glass beads distributed throughout its base cross-
 21 sectional area, with a reflective layer of beads bonded to the top surface.

22 The cold applied plastic markings shall adhere to the pavement by a pressure-sensitive
 23 pre-coated adhesive.

24 The cold applied plastic shall conform to pavement contours, breaks, faults, etc. through
 25 the action of traffic at normal pavement temperatures. The film shall have resealing
 26 characteristics such that it is capable of fusing with itself and previously applied marking
 27 tape of the same composition under normal conditions of use. The cold applied plastic
 28 pavement marking shall be patchable.

29 **1087-3 COLOR**

30 All pavement markings, without drop-on beads, shall visually match the color chips that
 31 correspond to the Federal Standard Number 595b for the following colors:

Crystal: Color No. 17886 (White)

Yellow: Color No. 13538

Black: Color No. 37038

32 **1087-4 GLASS BEADS**

33 **(A) Composition**

34 The silica content of the glass beads shall be at least 60%.

35 Manufacture the beads from 100% recycled non-pigmented glass from a composition
 36 designed to be highly resistant to traffic wear and to the effects of weathering. All
 37 standard intermix and drop-on glass beads shall be manufactured using 100% North
 38 American recycled glass cullet.

39 Glass beads shall have no more than 75 ppm of arsenic as determined by the United
 40 States Environmental Protection Agency Method 6010B in conjunction with the United
 41 States Environmental Protection Agency Method 3052 modified.

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1 (B) Physical Characteristics

2 Use glass beads that are colorless, clean, transparent and free from milkiness, excessive
3 air bubbles, skins and foreign objects. Use glass beads with a minimum refractive index
4 of 1.50 when tested by the liquid immersion method at 77°F ± 9°F in accordance with
5 ASTM D1214 using the Becke Line Method or an equivalent method. Use glass beads
6 that are spherical in shape and essentially free of sharp angular particles or particles
7 showing surface scarring or scratching.

8 All intermixed and drop-on glass beads shall comply with NCGS § 136-30.2.

9 (C) Gradation & Roundness

10 Use drop-on and intermixed glass beads in all pavement markings with at least 80% true
11 spheres when tested in accordance with ASTM D1155. Drop-on and intermixed glass
12 beads used on any pavement markings shall meet Table 1087-2.

Sieve Size	Gradation Requirements	
	Minimum	Maximum
Passing #20	100%	--
Retained on #30	5%	10%
Retained on #50	40%	80%
Retained on #80	15%	40%
Passing #80	0%	5%
Retained on #200	0%	5%

13 (D) Chemical Resistance

14 Conduct the following chemical resistance test on all glass beads:

15 Place 3 to 5 g portions of the same glass bead batch to be tested in 3 separate glass
16 beakers or 3 porcelain dishes. Cover one sample with distilled water, cover the second
17 sample with 3N solution of sulfuric acid and cover the third sample with 50% solution of
18 sodium sulfides. After one hour of immersion, examine the glass bead samples
19 microscopically for evidence of darkening or frosting. All 3 samples shall show no
20 evidence of darkening or frosting.

21 (E) Moisture Resistance

22 Conduct the following moisture resistance test on drop-on glass beads:

23 Place a 2 lb minimum sample of glass beads in a clean, washed cotton bag with a thread
24 count of 50 warp, 50 woof. Immerse the bag containing the sample in a container of
25 water for 30 seconds or until the water covers the spheres, whichever is longer. Remove
26 the bag from water and force excess water from the sample by squeezing the bag.
27 Suspend the bag and allow to drain for 2 hours at room temperature 70°F to 72°F. Then
28 mix the sample in the bag by shaking thoroughly. Transfer the sample slowly to a clean
29 dry glass funnel having a stem of 4" in length with 1/4" inside diameter. The entire
30 sample shall flow freely through the funnel without stoppage. When first introduced in
31 the funnel, if the spheres clog, it is permissible to lightly tap the funnel to start the flow.

32 1087-5 PACKAGING FOR SHIPMENT

33 Deliver all pavement marking and glass bead materials to the project in suitable containers
34 packaged by the manufacturer. Clearly and adequately mark each material container to
35 indicate the material, color, date of manufacture, process, batch or lot number, manufacturer's
36 name and location, temperature application range, shelf life and include the MSDS.

1 Thermoplastic pavement marking materials shall be in block or granular form packaged in
 2 either suitable corrugated containers or thermal degradable plastic bags to which it will not
 3 adhere during shipment or storage.

4 Package glass beads in moisture resistant packaging.

5 **1087-6 STORAGE LIFE**

6 All pavement marking materials shall meet this Specification for one year from the date of
 7 shipment from the manufacturer to the Contractor, or the project when stored properly by the
 8 manufacturer's recommendation. Replace any pavement marking materials not meeting these
 9 Specifications.

10 **1087-7 TESTS TO BE PERFORMED**

11 When independent test laboratory tests are required, perform them on samples taken by
 12 an agency certified by the Department from the same process, batch or lot number as the
 13 material shipped to the project. The test reports shall contain the lot number. Use
 14 Department approved independent test laboratories.

15 Perform the following tests on thermoplastic pavement marking materials, intermixed glass
 16 beads and drop-on glass beads unless prescribed otherwise by the Engineer:

17 **(A) Intermixed and Drop-on Glass Beads**

18 Use X-ray Fluorescence for the normal sampling procedure for intermixed and drop-on
 19 beads, without crushing, to check for any levels of arsenic. If any arsenic is detected, the
 20 sample shall be crushed and repeat the test using X-ray Fluorescence. If the test detects
 21 more than 75 ppm arsenic, perform tests as determined by the United States
 22 Environmental Protection Agency Method 6010B and 3052 modified. Drop-on glass
 23 beads or pavement markings containing glass beads with more than 75 ppm arsenic shall
 24 not be approved for use.

25 **(B) Thermoplastic Pavement Marking Material Composition**

26 (1) % Binder tested in accordance with ASTM D4797.

27 (2) % Titanium Dioxide Pigment tested in accordance with ASTM D3720 or D4764.

28 (3) % Lead Chromate Pigment tested in accordance with D4797.

29 (4) % Glass Beads tested in accordance with ASTM D4797.

30 Except ash, use a 100 gram sample rather than a 10 gram sample to allow for testing of
 31 gradation and percent of rounds. Provide the results of sieve analysis and % rounds.

32 **(C) Flash Point**

33 The thermoplastic shall have a flashpoint of no less than 500°F when tested in
 34 accordance with ASTM D92 COC.

35 **(D) Requirements**

36 The thermoplastic material after heating for 240 ± 5 minutes at $425 \pm 3^\circ\text{F}$ and cooled to
 37 $77 \pm 3^\circ\text{F}$ shall meet the following:

38 (1) Color

39 (a) White

40 Daylight reflectance 2° Standard observer and CIE illuminant

41 Using XYZ scale D65/10° - 80% minimum

42 ASTM E1349

43 Yellowness Index - The white thermoplastic shall not exceed a yellowness index
 44 of 0.12

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- 1 (b) Yellow
2 Daylight reflectance at 2° Standard observer and CIE illuminant
3 Using XYZ scale D65/10° - 45% minimum =Y
4 **ASTM E1349**
- 5 (2) Bond Strength
6 The bond strength shall be 200 psi or greater in accordance with **ASTM D4796**.
- 7 (3) Cracking Resistance at Low Temperatures
8 After applying a 4", 125 mil draw-down to concrete blocks and cooling to 15 ± 3°F,
9 the material shall show no cracks at an observation distance of 12".
- 10 (4) Specific Gravity
11 The specific gravity shall be 1.95-2.20 in accordance with **ASTM D792**.
- 12 (5) Softening Point
13 The softening point shall be 215 ± 15°F in accordance with **ASTM D36**.
- 14 (6) Drying Time
15 When applied at a thickness of 125 mils, the material shall set to bear traffic in no
16 more than 2 minutes when air and substrate temperature is 50°F ± 3°F (and no more
17 than 10 minutes when the air and substrate temperature is 90°F ± 3°F when applied
18 at temperature of 412.5 ± 12.5°F in accordance with AASHTO T 250.
- 19 (7) Alkyd Binder Determination
20 The thermoplastic material shall immediately dissolve in diacetone alcohol. Slow
21 dissolution is evidence of the presence of hydrocarbon binder components.
- 22 (8) Indentation Resistance
23 The Shore Type **A2** Durometer with a 4.41 lb load applied shall be between 40 and
24 75 units after 15 seconds at 115°F in accordance with **ASTM D2240**.

25 **1087-8 MATERIAL CERTIFICATION**

26 Furnish the following pavement marking material certifications in accordance with
27 Article 106-3:

Glass Beads	Type 3 Material Certification and Type 4 Material Certification
Paint	Type 3 Material Certification
Removable Tape	Type 3 Material Certification
Thermoplastic	Type 3 Material Certification and Type 4 Material Certification
Cold Applied Plastic	Type 2 Material Certification and Type 3 Material Certification
Polyurea	Type 3 Material Certification

28 **SECTION 1088** 29 **DELINEATORS**

30 **1088-1 REFLECTIVE UNIT REQUIREMENTS FOR DELINEATORS**

31 **(A) Definition**

32 Refer to **ASTM D4956**.

33 Define "entrance angle" as the angle at the reflector between direction of light incident on
34 it and direction of reflector axis.

1 Define "observation angle" and "specific intensity" in accordance with
2 Subarticle 1086-3(C)(3)(a).

3 **(B) Reflective Elements**

4 (1) Prismatic Plastic Type

5 (a) General

6 Use an acrylic plastic prismatic reflector hermetically sealed to an acrylic plastic
7 back. The reflector shall consist of a clear and transparent face, herein referred
8 to as a lens, with an acrylic plastic back fused to the lens under heat pressure
9 around the entire perimeter of the lens. Where a central mounting hole is
10 required, permanently seal the unit against dust, water and water vapor.

11 The lens shall consist of a smooth front surface free from projections or
12 indentations except a central mounting hole and identification markings. Mold
13 the manufacturer's trademark legibly into the face of the lens.

14 (b) Specific Intensity

15 Refer to [ASTM D4956](#).

16 The specific intensity of each prismatic plastic type reflector shall meet
17 Table 1088-1 measurements made with reflectors spinning. Failure to meet the
18 specific intensity minimum will constitute failure of the lot.

TABLE 1088-1 OPTICAL PROPERTIES OF PRISMATIC PLASTIC TYPE REFLECTORS				
Observation Angle (Degrees)	Entrance Angle (Degrees)	Minimum Specific Intensity (Candlepower per Footcandle)		
		<i>Crystal</i>	<i>Yellow</i>	<i>Red</i>
0.1°	0°	119	71	29
0.1°	15°	119	28	--
0.1°	20°	47	28	11
0.1°	35°	50	30	--

19 Locate the prismatic plastic type reflector to be tested at a distance of 100 ft
20 from a single light source having an effective diameter of 2" operate the light
21 source at approximately normal efficiency. Measure the return light from the
22 reflector by a photoelectric photometer having a minimum sensitivity
23 of 1 x 10 footcandles per mm scale division. The photometer shall have
24 a receiver aperture of 0.5" diameter, shielded to eliminate stray light. The
25 distance from light source center to aperture center shall be 2.1" for 0.1 degree
26 observation angle. During testing, spin the reflectors to average the orientation
27 effect.

28 If a test distance other than 100 ft is used, modify the source and aperture
29 dimensions, and the distance between source and aperture, in the same
30 proportion as the test distance.

31 (c) Durability

32 (i) Seal Test

33 Use the following test to determine if a reflector is adequately sealed
34 against dust and water:

35 Submerge 50 samples in water at room temperature. Subject the submerged
36 samples to a vacuum of 5" gauge for 5 minutes. Restore atmospheric
37 pressure and leave the samples submerged for 5 minutes, then examine the

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1 samples for water intake. Evidence of any water is a failure. Failure of
2 more than 2% of the number tested will be cause for rejection.

3 (ii) Heat Resistance Test

4 Test 3 reflectors for 4 hours in a circulating air oven at 175°+5°F. Place the
5 test specimens in a horizontal position on a grid or perforated shelf,
6 permitting free air circulation. At the conclusion of the test, remove the
7 samples from the oven and permit them to cool in air to room temperature.
8 The samples, after exposure to heat, shall show no change in shape and
9 general appearance when compared with unexposed control standards. Any
10 failures will be cause for rejection.

11 (2) High Performance Sheeting Grade

12 The reflective sheeting shall be Grade C retroreflective sheeting that conforms to
13 Article 1092-2.

14 1088-2 GUARDRAIL AND BARRIER DELINEATORS

15 (A) Brackets and Casings for Delineators

16 Make brackets for guardrail and barrier delineators out of 12 gauge galvanized steel,
17 0.063" thick aluminum alloy, or .080" thick polycarbonate. Use molded plastic type
18 guardrail and barrier delineators that consist of a plastic casing and a reflective element.

19 (B) Reflective Element Requirements

20 The reflective element shall meet Article 1088-1. In addition, guardrail delineators and
21 side mounted barrier delineators shall have a minimum reflective area of 7 sq.in. Top
22 mounted barrier delineators shall have a minimum reflective area of 28 sq.in.

23 (C) Material Certification

24 Furnish a Type 2 material certification in accordance with Article 106-3 for all guardrail
25 and barrier (permanent) delineators and a Type 7 material certification for all guardrail
26 and barrier delineators (temporary) before use.

27 (D) Approval

28 All materials are subject to the approval of the Engineer.

29 1088-3 GUARDRAIL END DELINEATION

30 (A) General

31 Use guardrail end delineation that is adhesive coated yellow reflective sheeting applied
32 with a pressure sensitive adhesive backing.

33 (B) Reflective Sheeting Requirements

34 Use Grade C yellow retroreflective sheeting which conforms to Article 1092-2 for all
35 guardrail end delineation. In addition, guardrail end delineation shall have a minimum
36 reflective area of 2 sf for curved end sections or cover the entire portion of square end
37 sections. See *Roadway Standard Drawings*.

38 (C) Material Certification

39 Furnish a Type 2 material certification in accordance with Article 106-3 for all guardrail
40 end delineation before use.

41 (D) Approval

42 All materials are subject to the approval of the Engineer.

1 1088-4 OBJECT MARKERS**2 (A) General**

3 Use 7 ft galvanized steel U-shaped channel posts as supports for delineators that are
4 fabricated from steel conforming to ASTM A36 or ASTM A409. Use 7 ft posts, which
5 weigh at least 1.12 lb/lf after fabrication and application of protective finish. Punch or
6 drill all posts with 3/8" diameter holes on the centerline, spaced on 1" centers, starting
7 1" from the top and extending at least 24" down the posts. Make sure that the holes are
8 clean and the posts are free of burrs. Hot dip galvanize the posts after fabrication for the
9 full length and total area in accordance with ASTM A123.

10 (B) Reflectors

11 Use 3" diameter prismatic plastic reflectors on object markers that meet
12 Subarticle 1088-1(B)(1).

13 (C) Reflective Sheeting Requirements

14 Use Grade C retroreflective sheeting on object markers that meet Article 1092-2.

15 (D) Panel Requirements

16 Use panels that meet Article 1092-1.

17 (E) Fasteners

18 Use fasteners that meet Article 1092-1.

19 (F) Material Certification

20 Furnish a Type 5 material certification in accordance with Article 106-3 for sheeting,
21 a Type 2 material certification for delineators and a Type 1 material certification for
22 U-channel posts before use.

23 (G) Approval

24 All materials are subject to the approval of the Engineer.

25 1088-5 TUBULAR MARKERS**26 (A) General**

27 Provide tubular markers that are made of ultraviolet stabilized plastic impact resistant
28 material and have been evaluated by NTPEP. Provide orange, yellow or white tubular
29 markers as shown in the plans.

30 Provide tubular markers that are flexible or have a flexible joint at the base, such that it
31 will return to its original shape and position if struck by a 5,000 lb vehicle at a velocity of
32 55 mph. When struck the tubular markers shall not permanently distort to a degree that
33 would prevent reuse.

34 Use tubular markers that are circular in shape and have a minimum height of 36" with
35 a broadened base. Use tubular markers that have a minimum height of 42" on roadways
36 with posted speed limits greater than 50 mph.

37 Design tubular markers that have white retroreflective collars or as shown in the contract.

38 Where retroreflective collars are required, provide Grade C retroreflective sheeting or
39 better that meets Article 1092-2. Use retroreflective sheeting bands with a minimum
40 width of 4" with 6" between the bands. Apply a continuous strip of sheeting completely
41 around the tubular marker to ensure 360° retroreflectivity.

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1 (B) Material Certification

2 Furnish a Type 3 material certification in accordance with Article 106-3 for all new
3 tubular markers and retroreflective collars and a Type 7 material certification for all used
4 tubular markers and retroreflective collars before use.

5 (C) Approval

6 All materials are subject to the approval of the Engineer.

7 1088-6 FLEXIBLE DELINEATOR

8 (A) General

9 Provide flexible delineators evaluated by NTPEP.

10 (B) Retroreflective Sheeting

11 Use retroreflective sheeting that is a minimum area of 16 sq.in., with a minimum width
12 of 3". The reflective sheeting shall be Grade C retroreflective sheeting or better and shall
13 conform to Article 1092-2.

14 Use retroreflective sheeting which is yellow, red or crystal, as shown in the plans. Attach
15 the retroreflective sheeting on the front and back of the delineator post as required by the
16 contract.

17 (C) Post

18 Design a delineator post that is flexible and made of recycled material. Provide
19 a delineator post that is resistant to impact, ultraviolet light, ozone, hydrocarbons and
20 stiffening with age.

21 Provide a post that is not seriously affected by exhaust fumes, asphalt or road oils, dirt,
22 vegetation, soil, deicing salts or any other types of air contamination or materials likely to
23 be encountered. Upon weathering, the post shall not exhibit serious discoloration,
24 checking or cracking, peeling or blistering, swelling, shrinking or distortion, or any other
25 detrimental effects. Weathering shall not cause appreciable strength or flexibility loss.

26 Design a post with a smooth surface that is free from irregularities or defects. The
27 surface of the post shall not soil excessively. If soiling does occur, it shall be easily
28 cleaned using detergent and water, or solvent.

29 Use posts that have a convex shaped cross-section. The cord distance for the cross-
30 section shall be from 3.5" to 4.5" in length.

31 Design a post such that it can maintain straightness throughout its entire life. Straight is
32 defined as no point along its length any more than 1" away from a perfectly straight edge
33 placed longitudinally along any side of the post.

34 Provide a post in which both sides of the top of the post accepts, and holds securely,
35 retroreflectorized sheeting.

36 Design posts that are gray in color.

37 (D) Base Support

38 Provide a base support that is hot rolled rail steel or new billet steel meeting
39 Article 1088-5, the physical requirements of ASTM A499 and the chemical requirements
40 of ASTM A1.

41 Use a base support that is a uniform flanged U-channel post with a nominal weight of
42 3 lb/ft before holes are punched. Use base support posts that are 18" in length and have
43 sufficient number of 3/8" diameter holes on 1" centers to facilitate attachment of the
44 flexible post.

1 (E) Anchoring

2 Design a delineator post for a permanent installation to resist overturning, twisting and
3 displacement from wind and impact forces.

4 (F) Temperature

5 Design flexible delineators that do not bend, warp or distort and remain straight, when
6 stored or installed at temperatures up to + 120°F. Design all components of the flexible
7 delineator, post and reflective sheeting to remain stable and remain fully functional
8 within a temperature range of - 20°F to + 120°F.

9 (G) Impact Resistance, Wind Resistance

10 Design flexible delineators that meet the impact and wind resistance of the current
11 evaluation criteria of the NTPEP.

12 (H) Product Identification

13 Provide flexible delineator post that are permanently identified, on the rear side, with the
14 manufacturer's name and the month and year of fabrication in order to provide a tracking
15 method for ongoing outdoor evaluation, and specification quality control. The letters
16 shall be at least 1/4" in height and permanently affixed to the rear of the marker.

17 (I) Material Certification

18 Furnish a Type 2 and Type 3 material certification in accordance with Article 106-3 for
19 all flexible delineators before use.

20 (J) Approval

21 All materials are subject to the approval of the Engineer.

22 **SECTION 1089**
23 **TRAFFIC CONTROL**

24 1089-1 WORK ZONE SIGNS**25 (A) General**

26 Grade B fluorescent orange sheeting shall be used on rigid work zone sign substrates.
27 The sheeting shall conform to Article 1092-2. Cover the entire sign face of the sign
28 substrate with Department approved Grade B fluorescent orange reflective sheeting. No
29 bubbles or wrinkles will be permitted in the material.

30 Roll-up sign retroreflective requirements shall conform to Article 1092-2.

31 (1) Work Zones Signs (Stationary)

32 Use Grade B fluorescent orange retroreflective sheeting that meets the reflective
33 requirements in Article 1092-2. Use approved composite or aluminum substrate for
34 sign backing. Signs and sign supports shall meet NCHRP 350 requirements for
35 breakaway devices.

36 (2) Work Zones Signs (Barricade Mounted)

37 Use approved composite or roll-up signs for barricade mounted sign substrates. No
38 other type of sign substrate is allowed on portable sign stands. Approved composite
39 barricade mounted warning signs (black on orange) shall be Grade B sheeting that
40 meets the retroreflective requirements of Article 1092-2. Sign and barricade
41 assembly shall meet NCHRP 350 for Work Zone Category II devices.

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(3) Work Zones Signs (Portable)

Use approved composite or roll-up sign substrates on portable sign stands. No other type of sign substrate is allowed on portable sign stands.

(a) Composite

Use Grade B fluorescent orange retroreflective sheeting that meets the reflective requirements in Article 1092-2. Signs and sign supports shall meet NCHRP 350 requirements for breakaway devices.

(b) Roll-up Signs

Use fluorescent orange retroreflective roll-up signs that meet the reflective requirements of Grade B in Article 1092-2.

Use roll up signs that have a minimum 3/16" x 1 1/4" horizontal rib and 3/8"x 1 1/4" vertical rib and has been crash test to meet NCHRP 350 requirements and Traffic Control qualified by the Work Zone Traffic Control Unit.

(B) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new reflective sheeting used on work zone signs meeting the retroreflective requirements of Article 1092-2. Furnish a Type 7 material certification for all used signs meeting the minimum retroreflective requirements of ASTM D4956.

(C) Approval

All materials are subject to the approval of the Engineer.

(D) Warranty

Refer to Subarticle 1092-2(B) for warranty requirements of rigid sign retroreflective sheeting.

Roll-up fluorescent orange retroreflective signs will maintain 80% of its retroreflectivity as described in Article 1092-2 for years 1 and 2 and 50% for year 3.

Rigid and rollup fluorescent orange signs shall maintain a fluorescence luminance factor of 13% for 3 years when measured in accordance with ASTM E2301.

Rigid and roll up fluorescent orange signs shall maintain a total luminance factor of 25 for 3 years and conform to Article 1092-2 when measured in accordance with ASTM D4956.

1089-2 WORK ZONE SIGNS SUPPORTS

(A) General

(1) Work Zone Signs (Stationary)

Provide work zone sign supports for work zone signs (stationary) that are sturdy, durable and crashworthy. Work zone signs (stationary) and their supports shall meet appropriate NCHRP 350 crash criteria for Category II work zone devices.

Use 3-lb U-channel steel posts, 4" x 4" wood posts or perforated square steel tubing posts for all work zone signs with surface areas greater than 16 sf. Dual mount signs with surface areas greater than 10 sf on either 3-lb U-channel steel posts, 4" x 4" wood posts or perforated square steel tubing posts having the equivalent or greater strength of 3-lb U-Channel Steel posts. Perforated square steel tubing breakaway posts certified by the manufacturer for single mounting purposes may be used for the single mounting of stationary work zone signs for signs greater than 10 sf.

1 Three-pound steel U-channel posts shall comply with Subarticle 1094-1(B) and may
2 be galvanized steel or painted green by the post manufacturer.

3 (2) Work Zone Signs (Portable)

4 Use work zone signs and portable work zone sign stands that are sturdy, durable and
5 crashworthy.

6 **(B) Material Certification**

7 Provide portable work zone signs and stands that are listed on the NCDOT Approved
8 Product List. Furnish a Type 3 material certification in accordance with Article 106-3 for
9 all new work zone sign (stationary) posts and a Type 7 material certification for all used
10 work zone sign (stationary) posts before use.

11 Furnish a Type 3 material certification in accordance with Article 106-3 for all new
12 portable work zone sign stand assemblies and a Type 7 material certification for all used
13 portable work zone sign stand assemblies before use.

14 **(C) Approval**

15 All materials are subject to the approval of the Engineer.

16 **1089-3 BARRICADES**

17 **(A) General**

18 Construct barricades out of perforated square steel tubing, angle iron or other Department
19 approved materials that meet or exceed NCHRP 350 crash criteria for Category II work
20 zone devices.

21 Use barricade rails constructed of approved composite, hollow/corrugated extruded rigid
22 polyolefin, HDPE or other Department approved material that have a smooth face and
23 alternating orange and white retroreflective stripes that slope at an angle of 45°.
24 Barricade rails shall meet or exceed NCHRP 350 crash criteria for Category II work zone
25 devices.

26 **(B) Supports**

27 Support barricade rails in a manner that shall be visible to the motorist and provide
28 a stable support not easily blown over by wind or traffic.

29 **(C) Reflective Sheeting**

30 Use Grade B retroreflective sheeting that meets Article 1092-2. Flame treat rails before
31 applying the sheeting if required by the sign sheeting manufacturer. Apply the reflective
32 sheeting with a pressure sensitive adhesive to both sides of the rails.

33 Use the same color sheeting on each rail of any individual barricade.

34 **(D) Material Certification**

35 Furnish a Type 3 material certification in accordance with Article 106-3 for all new
36 barricades and a Type 7 material certification for all used barricades before use.

37 **(E) Approval**

38 All materials are subject to the approval of the Engineer.

39 **1089-4 CONES**

40 **(A) General**

41 Use cones made of ultraviolet stabilized plastic impact resistant material meeting
42 MUTCD and this article. Orange will be the predominant color on cones.

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1 Use cones conical in shape with a minimum height of 28" or 36". The 28" cones shall
2 have a minimum base dimension of 13.75", and the 36" cones shall have a minimum base
3 dimension of 14.5" as shown in the *Roadway Standard Drawings*. The 28" and 36"
4 cones (excluding ballast) shall have a minimum weight of 7 lb and 10 lb respectively.
5 When in an upright position, have the cones display the same dimensions regardless of
6 their orientation to oncoming traffic.

7 (B) Ballast

8 Provide wind resistant cones that do not blow over under normal roadway conditions,
9 including high speed truck traffic in close proximity to the cones when properly ballasted.
10 Provide cones that do not permanently distort to a degree that would prevent reuse when
11 struck.

12 Achieve ballasting of the cones by using any of the following methods:

- 13 (1) Cones with bases that may be filled with ballast,
- 14 (2) Doubling the cones or using heavier weighted cones, or
- 15 (3) Cones with special weighted bases or weights such as rubber rings that can be
16 dropped over the cones and onto the base to provide increased stability.

17 Provide cones with 70% of the weight of the cone in the base. These added weights shall
18 not present a hazard if the devices are inadvertently struck.

19 (C) Retroreflective Sheeting

20 Where retroreflective cones are required, provide a cone with flexible, prismatic cone
21 sheeting having impact resistance and attached with precoated pressure sensitive
22 adhesive. The retroreflective sheeting shall meet or exceed the retroreflectivity
23 requirements of Grade B sheeting in Section 1092. Use 2 retroreflective bands, the top
24 one is 6" wide and the bottom one is 4" wide; see *Roadway Standard Drawings*.

25 (D) Material Certification

26 Furnish a Type 3 material certification in accordance with Article 106-3 for all new cones
27 with or without retroreflective sheeting and a Type 7 material certification for all used
28 cones with or without retroreflective sheeting before use.

29 (E) Approval

30 All materials are subject to the approval of the Engineer.

31 1089-5 CHANNELIZING DEVICES

32 (A) Drums

33 (1) General

34 Provide drums composed of a body, alternating orange and white 4 band pattern of
35 Type III-High Intensity or higher prismatic sheeting and ballasts evaluated by
36 NTPEP.

37 (2) Body

38 Provide a drum made of orange, impact resistant, ultraviolet plastic material capable
39 of maintaining its integrity upon impact throughout a temperature range of 20°F to
40 125°F. When struck, the drum shall not permanently distort to a degree that would
41 prevent reuse, nor roll excessively after impact. Design the drum to prevent water
42 from accumulating and freezing in the top or bottom.

1 Provide a drum that is cylindrical in shape with the following dimensions;
2 a minimum height of 36", a minimum top outer diameter of 18", a bottom outer
3 diameter of 21" to 24", and a minimum weight of 7 lb. The top outer diameter shall
4 not exceed the bottom outside diameter. Provide closed tops on drums to prevent
5 accumulation of debris.

6 (3) Retroreflective Stripes

7 Provide at least 4 retroreflective bands with 2 orange and 2 white alternating
8 horizontal circumferential bands. The top band shall always be orange. Use a 6" to
9 8" wide band Type III–High Intensity prismatic retroreflective sheeting or better that
10 meets Article 1092-2 for each band. Do not exceed 2" for any non-reflective spaces
11 between orange and white stripes. Do not splice the retroreflective sheeting to create
12 the 6" band. Apply the retroreflective sheeting directly to the drum surface. Do not
13 apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting.
14 Do not place bands over any protruding corrugations areas. No damage to the
15 reflective sheeting should result from stacking and unstacking the drums, or vehicle
16 impact.

17 (4) Ballast

18 Ballast drums using the sandbag ballast method, the tire sidewall ballast method or
19 by the preformed weighted base ballast method. When properly ballasted, the drums
20 shall be wind resistant to the extent of withstanding wind created by traffic under
21 normal roadway conditions, including high speed truck traffic in close proximity to
22 the drums. Do not place ballast on top of the drum.

23 (a) Sandbag Ballast Method

24 Supply a sandbag with 50 lb of sand with each drum. Place the sandbag inside
25 the body on top of the detachable base. Upon impact the main body of the drum
26 shall deform and become detached from the base, allowing vehicles to easily
27 pass over the remaining base.

28 (b) Tire Sidewall Ballast Method

29 Design the base of the drums to accommodate no more than 2 tire sidewalls that
30 when combined will have a weight of at least 30 lb and no more than 50 lb. Use
31 the manufacturer's required tire sidewall ballast. Upon impact the main body of
32 the drum shall deform and become detached from the tire sidewalls, allowing
33 vehicles to easily pass over the tire sidewall ballasts.

34 (c) Preformed Weighted Base Ballast Method

35 Supply a preformed base specifically designed for the model drum. The weight
36 of each drum's preformed base will be self-certified by the manufacturers. Each
37 drum with preformed bases shall be approved by the Work Zone Traffic Control
38 Unit. Upon impact, the main body of the drum shall deform and become
39 detached from the base allowing vehicles to easily pass over the remaining base.

40 (5) Material Certification

41 Furnish a Type 3 material certification in accordance with Article 106-3 for all new
42 drums and a Type 7 material certification for all used drums before use.

43 (6) Approval

44 All materials are subject to the approval of the Engineer.

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(B) Skinny Drums

(1) General

Provide skinny drums composed of a body, reflective stripes and ballasts evaluated by NTPEP.

(2) Body

Provide a skinny drum made of orange, impact resistant, ultraviolet plastic material capable of maintaining its integrity upon impact throughout a temperature range of -20°F to 125°F. When struck, the skinny drum shall not permanently distort to a degree that would prevent reuse, nor roll excessively after impact. Design the skinny drum to prevent water from accumulating and freezing in the top or bottom.

Provide a skinny drum that is cylindrical in shape with the following dimensions; a minimum height of 42", a minimum top outer diameter of 4" and a bottom outer diameter of 7.5". The top outer diameter shall not exceed the bottom outside diameter. Provide closed tops on drums to prevent accumulation of debris.

(3) Retroreflective Stripes

Provide at least 4 retroreflective bands with 2 orange and 2 white alternating horizontal circumferential bands for each skinny drum. The top band shall always be orange. Use a 6" to 8" wide band Type III-High Intensity or higher prismatic retroreflective sheeting that meets Article 1092-2 for each band. Do not exceed 2" for any non-reflective spaces between orange and white stripes. Do not splice the retroreflective sheeting to create the 6" band. Apply the retroreflective sheeting directly to the skinny drum surface. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting. Do not place bands over any protruding corrugation areas. No damage to the reflective sheeting should result from stacking and unstacking the skinny drums, or vehicle impact.

(4) Ballast

Ballast skinny drums using a preformed base specifically designed for the model skinny drum. Each base shall be at least 15 lb and circular or polygonal with equal sides. When properly ballasted, the skinny drums shall be wind resistant to the extent of withstanding wind created by traffic under normal roadway conditions including high speed truck traffic in close proximity to the skinny drums. Do not place ballast on top of the drum. Upon impact, the main body of the drum shall deform and become detached from the base allowing vehicles to easily pass over the remaining base.

(5) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new skinny drums and a Type 7 material certification for all used skinny drums before use.

(6) Approval

All materials are subject to the approval of the Engineer.

1089-6 FLASHING ARROW BOARDS

(A) General

Provide a trailer mounted arrow board that meets or exceeds the physical and operational requirements of the MUTCD and which has been evaluated by NTPEP. The following specifications supplement those basic requirements. Provide a totally mobile complete unit capable of being located as traffic conditions demand.

1 The display housing shall meet the minimum size requirements of a Type C panel with
2 a 15 or 25 lamp configuration.

3 The display housing shall have a hand-crank mechanism to allow raising and lowering
4 the display with a locking device to ensure the display housing will remain secured in
5 either position

6 The display housing will have a minimum height of 7 ft from the bottom of the sign to
7 the ground when raised in the upright position.

8 The display housing assembly shall be of weather resistant construction.

9 The lamps shall be controlled to provide the following modes as a minimum: Flashing
10 Right or Left Arrow, Flashing Double Arrow and Caution Mode (4 outermost corner
11 lamps).

12 **(B) Power System**

13 Provide a unit that is solar powered and supplemented with a battery backup system that
14 includes a 110/120 VAC powered on-board charging system.

15 The unit shall also be capable of being powered by standard 110/120 VAC power source.

16 The batteries, when fully charged, shall be capable of powering the display for
17 20 continuous days with no solar power.

18 Store the battery bank and charging system in a lockable, weather and vandal resistant
19 box.

20 **(C) Controller**

21 Provide an automatic brightness/dimming of the display and a manual override dimming
22 switch.

23 The controller shall provide a battery-charge status indicator.

24 Mobile radio or any other radio transmissions shall not affect the controller.

25 Store the controller in a lockable, weather and vandal resistant box.

26 **(D) Trailer**

27 Finish all exterior metal surfaces with Federal orange enamel per Federal Standard 595a,
28 color chip ID# 13538 or 12473 respectively. The trailer shall be able to support
29 a 100 mph wind load with the display fully extended.

30 The trailer shall be equipped with leveling jacks capable of stabilizing the unit in
31 a horizontal position when located on slopes 6:1 or flatter.

32 The trailer shall be properly equipped in compliance with North Carolina Law governing
33 motor vehicles.

34 Provide a minimum 4" wide strip of fluorescent orange retroreflective sheeting to the
35 frame of the trailer. Apply the sheeting to all sides of the trailer. The sheeting shall meet
36 the requirements of Section 1088-1. Drums may be supplemented around the unit in
37 place of the sheeting.

38 **(E) Reliability**

39 Provide a sign unit that all components are rated to operate at temperatures ranging from
40 -30°F to 165°F.

41 The sign manufacturer shall notify the Work Zone Traffic Control Unit whenever
42 modifications are made to a prequalified sign on the NCDOT Approved Products List.

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1 The Work Zone Traffic Control Unit will review changes and per its discretion either
2 make no change to the sign's status or remove it from the list until the sign can be
3 reevaluated.

4 (F) Material Certification

5 Furnish a Type 3 material certification in accordance with Article 106-3 for all new
6 flashing arrow boards, a Type 7 material certification for all used flashing arrow boards,
7 and wind load certifications required in Subarticle 1089-6(D) for all new and used
8 flashing arrow boards before use.

9 (G) Approval

10 The sign shall be on the NCDOT Approved Products List before use on construction
11 projects in North Carolina. A sign may be removed from the NCDOT Approved
12 Products List due to unsatisfactory field performance and shall not return to the list until
13 the manufacturer identifies the reason for the failure and the problem has been corrected
14 to the satisfaction of the Department.

15 The sign manufacturer shall notify the Department whenever modifications are made to
16 their sign that was prequalified on the NCDOT Approved Products List. The Department
17 will review changes and per its discretion, either make no change to the sign's status on
18 the NCDOT Approved Products List or remove the sign from the list until the sign can be
19 reevaluated.

20 1089-7 PORTABLE CHANGEABLE MESSAGE SIGNS

21 (A) General

22 Provide trailer mounted portable changeable message signs that meet MUTCD and have
23 been evaluated by NTPEP.

24 Provide a totally mobile complete sign unit capable of being located as traffic conditions
25 demand.

26 (B) Display Panel

27 Provide 3 lines of a programmable message with at least 8 characters per line and
28 a character height of at least 18".

29 The display characters will be composed of LED elements. The display panel may be of
30 the following types- Full Matrix, Continuous Line Matrix, and Character Matrix.

31 Messages are to be automatically centered and proportionally spaced on each line of
32 a Full Matrix and Continuous Line Matrix displays. Character Matrix displays shall
33 display odd number character messages one character left of the centerline.

34 The display characters shall be protected with a polycarbonate lens that shall not decrease
35 the daytime visibility of the sign.

36 The display panel shall have an electro-hydraulic system to allow raising and lowering
37 the display with 360° rotation capability. A locking device(s) shall be provided to ensure
38 the display will remain secure in the raised, lowered and rotated positions. The sign shall
39 have the capability to be raised and rotated to its operating position by one person.

40 A manual backup mechanism for the raising and lowering the display panel shall be
41 provided in the event the electro-hydraulic system fails.

42 The display panel assembly shall be of weather resistant construction

43 (C) Power System

44 The unit shall be Solar powered and supplemented with a battery backup system which
45 includes a 110/120 VAC powered on-board charging system.

1 The batteries, when fully charged, shall be capable of powering the display for
 2 20 continuous days with no solar power. The unit shall be capable of being powered by
 3 standard 110/120 VAC power source.

4 Store the battery bank and charging system in a lockable, weather and vandal resistant
 5 box.

6 **(D) Controller**

7 The controller shall provide at a minimum; a keyboard, a display for message review and
 8 editing, a light source for nighttime operations, an event time clock and all other required
 9 controls for the operation of the display. Access to controller operations shall have the
 10 capability to be password protected.

11 The controller shall include the following capabilities; manually dimming the display,
 12 storing at least 99 user generated messages, adjusting the flash rate of display and display
 13 phasing and monitoring battery-charge status.

14 Mobile radio or any other radio transmissions shall not affect the controller.

15 The controller shall be stored in a lockable, weather and vandal resistant box.

16 The controller shall be pre-programmed with messages shown below and stored in
 17 memory:

MAX SAFE SPEED 25 MPH	MAX SAFE SPEED 30 MPH
STOP AHEAD	YIELD AHEAD
MAX SAFE SPEED 35 MPH	MAX SAFE SPEED 40 MPH
MAX SAFE SPEED 45 MPH	MAX SAFE SPEED 50 MPH
ONE LANE BRIDGE	SURVEY CREW
MAX SAFE SPEED 55 MPH	DETOUR AHEAD
CAUTION DETOUR AHEAD	LANE CLOSED AHEAD
RIGHT LANE CLOSED	LEFT LANE CLOSED
CENTER LANE CLOSED	SINGLE LANE AHEAD
MERGE LEFT	MERGE RIGHT
KEEP LEFT	KEEP RIGHT
PASS LEFT	PASS RIGHT
USE LEFT LANE	USE RIGHT LANE
MERGE AHEAD	ROAD MACHINES AHEAD
ROAD WORK AHEAD	FLAGGER AHEAD
BUMP	DIP
STOP AHEAD	YIELD AHEAD
BE PREPARED TO STOP	SIGNAL AHEAD
SIGNAL NOT WORKING	DO NOT PASS
ONE LANE BRIDGE	SURVEY CREW
SHOULDER WORK	SOFT SHOULDER
PAVEMENT ENDS	LANE ENDS
ROAD CLOSED 1/4 MILE	ROAD CLOSED 1/2 MILE
ALL TRAFFIC EXIT LEFT	ALL TRAFFIC EXIT RIGHT
ROAD NARROWS	ROAD CLOSED AHEAD
RAMP CLOSED	REDUCE SPEED
ROAD PAVING AHEAD	ALL TRAFFIC MUST STOP
SLOW MOVING TRAFFIC	NIGHT WORK AHEAD
CAUTION FLAGGER AHEAD	RUNAWAY TRUCK RAMP
MEDIAN WORK AHEAD	
LEFT LANE NARROWS	RIGHT LANE NARROWS
TEST PATTERN A ^A	TEST PATTERN B ^B

18 **A.** Test Pattern A is 1/2 of the LEDs/flip-discs/or combination on at a time.

19 **B.** Test Pattern B is for the remaining 1/2 of the LEDs/flip-discs/or combination on at
 20 a time.

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1 (E) Trailer

2 Finish all exterior metal surfaces with Federal orange enamel per Federal Standard 595a;
3 color chip ID# 13538 or 12473 respectively except for the sign face assembly that shall
4 be flat black.

5 Provide a minimum 4" wide strip of fluorescent orange retroreflective sheeting to the
6 frame of the trailer. Apply the sheeting to all sides of the trailer. The sheeting shall meet
7 Article 1088-1. Drums may be supplemented around the unit in place of the sheeting.

8 The trailer shall be able to support a 100 mph wind load with the display fully extended.

9 The trailer shall be equipped with leveling jacks capable of stabilizing the unit in
10 a horizontal position when located on slopes 6:1 or flatter.

11 The trailer shall be properly equipped in compliance with North Carolina Law governing
12 motor vehicles.

13 (F) Reliability

14 Provide a sign unit that all components are rated to operate at temperatures ranging from
15 -30°F to 165°F.

16 (G) Material Certification

17 Furnish a Type 3 material certification in accordance with Article 106-3 for all new
18 changeable message signs, a Type 7 material certification for all used changeable
19 message signs and wind load certifications required in Subarticle 1089-7(E) for all new
20 and used changeable message signs before use.

21 (H) Approval

22 The sign shall be on the NCDOT Approved Products List before use on construction
23 projects in North Carolina. A sign may be removed from the NCDOT Approved
24 Products List due to unsatisfactory field performance and shall not return to the list until
25 the manufacturer identifies the reason for the failure and the problem has been corrected
26 to the satisfaction of the NCDOT.

27 The sign manufacturer shall notify NCDOT whenever modifications are made to their
28 sign that was prequalified on the NCDOT Approved Products List. The Department will
29 review changes and per its discretion either make no change to the sign's status on the
30 NCDOT Approved Products List or removed the sign from the list until the sign can be
31 reevaluated.

32 1089-8 TEMPORARY CRASH CUSHIONS

33 (A) General

34 Provide temporary crash cushions that meet NCHRP 350 for Work Zone Test Level 2 for
35 work zones that have a posted speed limit of 45 mph or less. Provide temporary crash
36 cushions that meet NCHRP 350 for Work Zone Test Level 3 devices for work zones that
37 have a posted speed limit of 50 mph or greater. Provide temporary crash cushions that
38 shall remain intact after a side impact, and without maintenance, be capable of sustaining
39 additional side or head-on impacts.

40 Contain the temporary crash cushion debris resulting from impact within the structure of
41 the temporary crash cushion.

42 Include in the temporary crash cushion package any required rear transition panels to
43 connect the back of the temporary crash cushion to rigid or flexible barrier systems as
44 well as any required portable base as recommended by the manufacturer of the temporary
45 crash cushion, to connect the bottom of the temporary crash cushion to a paved surface.
46 Temporary crash cushion shall not be placed on an unpaved surface.

(B) Retroreflective End Treatments

Provide a yellow nose wrap that visually matches the color chip that corresponds to the Federal Standard No. 595a for Yellow (Color No. 13538) for all temporary crash cushions.

The reflective end treatment shall meet the requirement for reflectivity in Article 1088-1 and *Roadway Standard Drawings*.

(C) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new temporary crash cushions and a Type 7 material certification for all used temporary crash cushions before use.

(D) Approval

Use temporary crash cushions that are on the NCDOT Approved Products List.

1089-9 TRUCK MOUNTED ATTENUATORS**(A) General**

Provide truck mounted attenuators that meet NCHRP 350 Test Level II for work zones that have a posted speed limit of 45 mph or less. Provide truck mounted attenuators that meet NCHRP 350 Test Level III for work zones that have a posted speed limit of 50 mph or greater.

Use trucks with gross vehicle tare weight as described in the NCHRP 350 crash test for the impact attenuator provided. Provide 2 axle flat bed type trucks with minimum gross vehicle tare weight of 5,000 lb that may be ballasted with sections of portable concrete barrier attached to the bed of the truck with bolts or straps, or concrete poured into the bed of the truck and attached to the truck with bolts, or a continuous layer of asphalt placed in the bed of the truck and attached to the truck with bolts.

Mount the attenuator on a truck chassis to provide a uniform clearance, as required by the truck mounted attenuator's manufacturer, between the bottom of the shell and the roadway. Use a steel backup support assembly of sufficient size and strength to permit mounting on the chassis by brackets, as required by truck mounted attenuator's manufacturer.

Provide truck mounted attenuators equipped with cartridges that have a standard trailer lighting system, including brake lights, tail lights and turn signals.

(B) Retroreflective End Treatment

The reflective end treatment shall meet Article 1088-1 and *Roadway Standard Drawings*.

(C) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new truck mounted attenuators and a Type 7 material certification for all used truck mounted attenuators before use.

(D) Approval

Use only truck mounted attenuators that are on the NCDOT Approved Products List.

Section 1090

1 1089-10 FLAGGER

2 (A) Stop and Slow Paddle

3 (1) Reflective Sheeting

4 Use reflective sheeting with a smooth, sealed outer surface that will display the same
5 color both day and night. Cover the entire sign face with Grade B reflective
6 sheeting. Reflective sheeting shall meet Article 1092-2. The distance from the
7 bottom of the sign to the ground shall be at least 7 ft.

8 (2) Material Certification

9 Furnish a Type 3 material certification in accordance with Sections 106-3 for all new
10 reflective sheeting used on flagger paddles and a Type 7 material certification for all
11 used sheeting before use.

12 (3) Approval

13 All materials are subject to the approval of the Engineer.

14 (B) Vest

15 (1) Reflective Sheeting

16 Use reflective sheeting with sealed outer surface that will display the same color both
17 day and night. Design the reflective sheeting similar to Department chevron vests.
18 Reflective sheeting shall meet Article 1092-2.

19 (2) Material Certification

20 Furnish a Type 3 material certification in accordance with Sections 106-3 for all new
21 reflective sheeting and a Type 7 material certification for all used sheeting on flagger
22 vests before use.

23 (3) Approval

24 All materials are subject to the approval of the Engineer.

25 SECTION 1090

26 PORTABLE CONCRETE BARRIER

27 1090-1 PORTABLE CONCRETE BARRIER

28 (A) General

29 Use portable concrete barrier that meets Section 854, Section 1077 and the plans. The
30 requirement for approved galvanized connectors will be waived if the barrier remains the
31 property of the Contractor.

32 (B) Used Portable Concrete Barrier

33 Used barrier will be acceptable provided the following conditions have been met:

34 (1) The Contractor has furnished a Type 7 material certification in accordance with
35 Article 106-3.

36 (2) The strength of the concrete in each barrier unit is at least 4,500 psi as evidenced by
37 nondestructive tests made in place by a rebound hammer in accordance with
38 ASTM C805.

39 (C) Anchor Bolts

40 Use anchor bolts that meet ASTM A325.

41 (D) Approval

42 All materials are subject to the approval of the Engineer.

**SECTION 1091
ELECTRICAL MATERIALS**

1091-1 GENERAL REQUIREMENTS

(A) New Materials

Furnish new equipment, materials and hardware unless otherwise specified.

(B) Electrical Industry Standards

Provide electrical materials labeled and listed by UL when available or an electrical industry standards organization acceptable to the Engineer. The listing organization shall maintain periodic inspection of the production of materials and shall, by the labeling or listing procedure, verify that the materials comply with appropriate standards of performance or are suitable for use in a specified manner.

(C) Certification

Furnish a Type 3 material certification in accordance with Article 106-3.

1091-2 Wire and Cable

Use only stranded copper conductors, unless otherwise shown in the contract or *Standard Specifications*. Provide wire and cable with identification labels or tags on either the wire or cable itself or on the coil, reel or smallest container in which the product is packaged when delivered to the project. Show the manufacturer's name, gauge, UL symbol and type of wire or cable on the identification label or tag. When requested by the Department, furnish samples of wire and cable to the Department at no additional cost.

Use wire and cable of the type and size shown in the contract meeting the following applicable UL standards: 44, 83, 493, 719, 854, 1063 and 1581.

Where required by the plans, use soft or annealed solid bare copper wire conforming to ASTM B3.

1091-3 CONDUIT

(A) Conduit Bodies, Boxes and Fittings

Use conduit bodies, boxes, and fittings that meet UL Standard 514A or 514B for electrical and communications installations.

(B) Rigid Metallic Conduit

Provide rigid hot dipped galvanized steel conduit that meets UL Standard 6 with rigid full weight sherardized or galvanized threaded fittings.

(C) PVC Conduit

Provide non-metallic conduit and duct including associated couplings, approved for above and below ground use with or without concrete encasement in accordance with UL Standard 651A. Provide Schedule 40 conduit unless otherwise specified.

(D) Liquid-Tight Flexible Metal Conduit

Provide conduit that meets UL Standard 360 that is acceptable for equipment grounding in accordance with the NEC. Ensure conduit has insulated throat and malleable iron watertight fittings.

(E) Liquid-Tight Flexible Nonmetallic Conduit

Provide conduit that meets UL Standard 1660.

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1 (F) Solid Wall HDPE Conduit

2 Use HDPE conduit that conforms to UL Standard 651B. Provide conduit meeting
 3 Table 1091-1 with minimum wall thickness ratios corresponding to
 4 EPEC-40 (Schedule 40), EPEC-80 (Schedule 80) or EPEC-B (SDR 13.5) as listed in
 5 UL Standard 651B, Table 5.1, 5.2 and 5.3.

TABLE 1091-1 HDPE CONDUIT SIZE	
Conduit Trade Size	Furnish
1"	EPEC-40
1 1/4"	EPEC-40
1 1/2"	EPEC-B (SDR 13.5)
2"	EPEC-B (SDR 13.5)
2 1/2"	EPEC-B (SDR 13.5)
3"	EPEC-B (SDR 13.5)
4"	EPEC-B (SDR 13.5)
5"	EPEC-80
6"	EPEC-80

6 Ensure the PE resin compounds used in manufacturing the conduit meet or exceed the
 7 cell classification PE 334420C (black with 2% minimum carbon black) or
 8 PE 334420E (colored conduit with UV inhibitors) in ASTM D3350 and Table 1091-2.

TABLE 1091-2 RESIN PROPERTIES		
Property	Requirement	Test Method
Density	0.940 - 0.947g/cm ³	ASTM D1505 ASTM D792 ASTM D4883
Melt Index (condition 190/2.16 is acceptable)	< 0.4 grams/10 minutes	ASTM D1238
Flexural Modulus	80,000 psi, min.	ASTM D790
Tensile Strength	Tensile Strength 3,000 psi, min.	ASTM D638
Elongation	Elongation 400%, min.	ASTM D638
Slow Crack Growth Resistance	An ESCR as per condition B, 10% IGEPAL requirement of F50 > 24 hrs is allowable	ASTM D1693
Hydrostatic Design Basis	"0" for Non-Pressure Rated Pipe	ASTM D2837
UV Resistance (Outdoor Conduit Only)	Stabilize with at least 2% by weight carbon black or colored with UV Inhibitor	ASTM D4218

9 Furnish conduits in the colors for the applications shown in Table 1091-3. For conduits
 10 manufactured with stripes, ensure the stripes are uniformly located around the conduit
 11 with 120 degrees of separation. Do not use "Solid Yellow" or "Black with Yellow
 12 Stripes" conduit.

**TABLE 1091-3
CONDUIT COLORS**

Conduit Contents	Preferred Solid Color	Alternate
Signal Cable	Black	None
Loop Lead-in Cable	White	Black with White Stripes
Communication Cable (Copper, Fiber Optic, Coaxial)	Orange	Black with Orange Stripes
Electrical Power Cable	Red	Black with Red Stripes

1 Ensure the HDPE conduit is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil,
2 gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate and
3 transformer oil and is protected against degradation due to oxidation and general
4 corrosion.

5 Furnish factory lubricated, low friction, conduit with a coefficient of friction of 0.10 or
6 less in accordance with Telcordia GR-356.

7 Ensure the supplied conduit is identified and certified as meeting, UL Standard 651B.
8 Ensure the conduit is marked at least with the following information on 10 ft or less
9 intervals:

10 (1) Material: HDPE

11 (2) Trade Size: i.e., 2"

12 (3) Conduit Type: SDR 13.5 or EPEC-B

13 (4) Manufacturer's name or trademark

14 (5) Manufacturer's identity code to identify manufacturing date, facility, etc.

15 (6) UL symbol or UL listing number

16 Furnish coilable conduit that is supplied on reels in continuous lengths for transportation
17 and storage outside. Ensure that the process of installing the coilable conduit on the reel
18 does not alter the properties or performance of the conduit for its intended purpose.

19 **(G) Conduit Plugs, Pull Line and Tracer Wire**

20 Furnish conduit plugs that provide a watertight barrier when installed in conduit. Furnish
21 conduit plugs sized in accordance with conduit. Ensure conduit plug provides a means to
22 secure a pull line to the end of the plug. Provide removable and re-usable conduit plugs.
23 Conduit plugs are not required to be listed electrical devices.

24 For all spare conduits, furnish 3/4", pre-lubricated, woven polyester tape, pull line with
25 minimum rated tensile strength of 2,500 lb. Pull lines are not required to be listed
26 electrical devices.

27 Provide green insulated number 14 AWG, THWN, stranded copper wire to serve as
28 tracer wire.

29 **1091-4 DUCT AND CONDUIT SEALER**

30 Use duct and conduit sealer or mastic which is a putty-like compound and:

31 **(A)** Is permanently non-hardening, non-oxidizing, and non-corrosive to metals, rubber,
32 plastic, lacquer and paints;

33 **(B)** Is readily workable for thumbing into openings and forming into seals around wires
34 inside conduits and openings around conduits;

35 **(C)** Has a service temperature range of minus 30°F to 200°F;

36 **(D)** Is clean, non-poisonous and non-injurious to human skin;

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1 (E) Seals against water, dust and air and shall adhere to wood, glass, plastics, metal, rubber
2 and painted surfaces; and

3 (F) Is non-conductive.

4 1091-5 ELECTRICAL JUNCTION BOXES

5 (A) General

6 Provide electrical junction boxes with covers of the type and size indicated by the
7 contract or plans for the termination of conduits.

8 (B) Polymer Concrete (PC) Junction Boxes

9 Provide polymer concrete (PC) boxes which are stackable, have bolted covers and have
10 open bottoms. Ensure vertical extensions of 6" to 12" are available from the junction box
11 manufacturer.

12 Use polymer concrete material made of an aggregate consisting of sand and gravel bound
13 together with a polymer and reinforced with glass strands to fabricate box and cover
14 components which are exposed to sunlight. Other thermosetting glass-reinforced
15 materials may be used for components which are not normally exposed to sunlight.

16 Provide certification that the polymer concrete boxes and covers meet
17 Tier 15 requirements of ANSI/SCTE 77. Provide certification that testing methods are
18 compliant with ANSI/SCTE 77.

19 Provide the required logo on the cover. Provide at least 2 size 3/8" diameter hex head
20 stainless steel cover bolts to match inserts in the box. Provide pull slot(s) with stainless
21 steel pin(s). Polymer concrete junction boxes are not required to be listed electrical
22 devices.

23 (C) Cast Metal (BR) Junction Boxes

24 Provide cast-metal (BR) box, replaceable frame and cover that are hot dipped galvanized
25 with factory or field drilled conduit entrances. Provide a cover with checkered imprint,
26 pry bar slots, and reinforcing ribs for heavy loading, neoprene gasket, and brass or
27 stainless steel bolts. Provide a blind tapped (1/4" NC thread minimum) boss on interior
28 of box for grounding.

29 1091-6 GROUNDING ELECTRODES

30 Provide grounding electrodes of the following types as indicated in the specifications and
31 plans.

32 (A) Ground Rods

33 Provide 5/8" diameter, 10 ft long, copper-clad steel ground rods with 10 mil thick copper
34 cladding.

35 (B) Sectional Ground Rods

36 Provide sectional ground rods comprised of 5/8" diameter, 10 ft long, steel ground rods
37 with 10 mil thick copper cladding, welded together in a butt configuration with
38 an exothermic weld. As an alternative, provide UL listed bronze couplers designed to
39 connect 5/8" diameter copper-clad steel rods. Do not use threaded ground rods or
40 threaded couplers. Provide minimum lengths required by plans.

SECTION 1092
SIGNING MATERIALS

1092-1 SIGNS AND HARDWARE

Fabricate signs from aluminum alloy sheets. Use supporting frames and accessories made of aluminum. Use galvanized steel backing plates and mounting bolts. Use materials that conform to Tables 1092-1 and 1092-2.

Filler metal shall conform to Section 10(3) of the *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Aluminum sign studs, welded to the sign panels in accordance with Article 901-3, shall be capable of withstanding a direct pull-out load of 400 lb. Furnish a Type 3 material certification in accordance with Article 106-3 demonstrating conformance to this requirement. The Materials and Tests Unit will take samples of the studs and make random field tests of the welded studs to verify the statement of certification. Failure of more than 10% of the studs tested on any one sign will be sufficient evidence for rejection of stud welding on the entire sign. When tested in tension, the studs shall not fail in the weld area, but fail in the threaded portion of the stud.

Drill bolt holes and slots to finished size or they may be punched to finished size, provided the diameter of the punched holes is at least twice the thickness of the metal being punched. Flame cutting of bolt holes and slots will not be permitted. No galvanizing of any steel part will be allowed until all welding, cutting, milling, punching, and drilling of the part has been completed.

TABLE 1092-1
ALUMINUM SIGN MATERIALS

Aluminum Materials	Alloy Specification	Test Method
Extruded Bars	6061-T6	ASTM B221
Sheets and Plates	6061-T6, 5052-H38 or 3004-H38	ASTM B209
Structural Shapes	6061-T6	ASTM B308
Standard Weight Pipe	6061-T6	ASTM B241
Castings	356-T7	ASTM B26
Bolts	6061-T6, 2024-T4 ^A	ASTM B211
Nuts (1/4" Tap and under)	2024-T4 ^A , 6061-T6 or 6262-T9	ASTM B211
Nuts (5/16" Tap and over)	2024-T4 ^A , 6061-T6 or 6262-T9	ASTM B211
Nuts (3/8" Self-locking)	2017-T4, 6061-T6	ASTM B211
Washers (std. flat) Alclad	2024-T4 ^A or 6061-T6	ASTM B209
Washers (std. lock)	7075-T6	ASTM B211
Welded Studs (1/4")	5356-H12 or 5356-H32	ASTM B211

A. The alloy shall have anodic coating of 0.0002" minimum thickness with dichromate or boiling water seal

TABLE 1092-2
STEEL SIGN MATERIALS

Galvanized Steel Materials	Test Method for Base Metal	Test Method for Galvanizing
Structural Shapes and Plates	ASTM A36	ASTM A123
Standard Weight Black Pipe	ASTM A53	ASTM A123
Bolts and Nuts	ASTM A307	ASTM F2329
Washers (std. flat and lock)	ASTM A307	ASTM F2329
High Strength Bolts, Nuts and Washers	ASTM A325	ASTM B695 Class 55

Section 1092

1 1092-2 RETROREFLECTIVE SHEETING

2 Reflectorize all signs. Use colors and sheeting grades of the sign backgrounds and messages
 3 as shown in the contract. After preparation of the sign panels, in accordance with
 4 Subarticle 901-3(D), apply retroreflective sheeting as required herein. The retroreflective
 5 sheeting shall consist of white or colored sheeting having a smooth outer surface and the
 6 property of a retroreflector over its entire surface.

7 Retroreflective sheeting shall meet **ASTM D4956** and are listed on the NCDOT Approved
 8 Products List.

9 The reflective material specified herein is intended for use on surfaces of various traffic
 10 control devices, including drums, barricades, traffic cones and highway signs, to assure their
 11 adequate visibility at all times upon exposure to a light source when totally dry or wet.
 12 Provide reflectorization that produces a wide-angle retroreflectivity, enhancing nighttime
 13 visibility. This retroreflective sheeting shall consist of encapsulated, enclosed lens or
 14 prismatic with a transparent plastic having a smooth, flat outer surface. Provide material that
 15 is flexible, of good appearance, free from ragged edges, cracks and extraneous materials, and
 16 exhibits good quality workmanship.

17 (A) Performance and Test Requirements

TABLE 1092-3 MINIMUM COEFFICIENT OF RETROREFLECTION FOR NC GRADE A (Candelas Per Lux Per Square Meter)								
Observation Angle, degrees	Entrance Angle, degrees	White	Yellow	Green	Red	Blue	Fluorescent Yellow Green	Fluorescent Yellow
0.2	-4.0	525	395	52	95	30	420	315
0.2	30.0	215	162	22	43	10	170	130
0.5	-4.0	310	230	31	56	18	245	185
0.5	30.0	135	100	14	27	6	110	81
1.0	-4.0	80	60	8	16	3.6	64	48
1.0	30.0	45	34	4.5	9	2	36	27

TABLE 1092-4 MINIMUM COEFFICIENT OF RETROREFLECTION FOR NC GRADE B (Candelas Per Lux Per Square Meter)									
Observation Angle, degrees	Entrance Angle, degrees	White	Yellow	Green	Red	Blue	Fluorescent Yellow Green	Fluorescent Yellow	Fluorescent Orange
0.2	-4.0	380	285	38	76	17	300	230	115
0.2	30.0	215	162	22	43	10	170	130	65
0.5	-4.0	240	180	24	48	11	190	145	60
0.5	30.0	135	100	14	27	6	110	81	30
1.0	-4.0	80	60	8	16	3.6	64	48	7.5
1.0	30.0	45	34	4.5	9	2	36	27	5.6

TABLE 1092-5
MINIMUM COEFFICIENT OF RETROREFLECTION FOR NC GRADE C
(Candelas Per Lux Per Square Meter)

Observation Angle, degrees	Entrance Angle, degrees	White	Yellow	Green	Red	Blue	Brown
0.2	-4.0	250	170	45	45	20	12
0.2	30.0	150	100	25	25	11	8.5
0.5	-4.0	95	62	15	15	7.5	5
0.5	30.0	65	45	10	10	5	3.5

1 For areas printed with transparent colors, the coefficient of retroreflection shall not
2 be less than 70% of the values for the corresponding color.

3 (1) Adhesive

4 Meet **ASTM D4956**.

5 (2) Field Performance

6 The fabricating agency will date all signs (month, year) at the completion of
7 fabrication. That date constitutes the start of the field performance obligation period.

8 **(B) Manufacturer's Warranty and Obligations**

9 (1) Warranty

10 The sheeting manufacturer warrants to the Department that all materials furnished
11 under this Specification will be new, of good components and workmanship and
12 agrees to the following conditions.

13 Retroreflective sheeting processed and applied to sign blank materials in accordance
14 with the manufacturer's manuals shall be warranted by the manufacturer to perform
15 effectively as stated in this section. The manufacturer's manuals shall contain
16 a complete descriptive explanation of all the requirements necessary of the sign
17 fabricator.

18 (2) Obligation Grades A, B and C

19 (a) Years 1 through 7 (Years 1 Through 2 for Fluorescent Orange)

20 Cover the cost of restoring the sign face in its field location to its original
21 effectiveness at no cost to the Department for materials, labor and equipment.
22 In addition to the reflective requirements for Grade B fluorescent orange, the
23 sheeting shall at least maintain a total Luminance Factor (Y) of 25
24 **(ASTM D4956)** and a Fluorescence Luminance Factor (YF) of 13%
25 **(ASTM E2301)** for 3 years. Maintain at least 80% of fluorescent orange
26 sheeting reflectivity for years 1 and 2.

27 (b) Years 8 through 10 (Year 3 for Fluorescent Orange)

28 Replace the sheeting required to restore the sign face to its original
29 effectiveness. Maintain 50% of fluorescent orange sheeting reflectivity for
30 year 3.

31 (c) Years 11 through 12

32 Replace 50% of the sheeting required to restore the sign face to its original
33 effectiveness.

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1 1092-3 CERTIFICATION

2 Provide a Type 6 material certification in accordance with Article 106-3 for all retroreflective
3 sheeting used in the manufacture of signs certifying that the sheeting meets Section 1092.

4 SECTION 1094 5 GROUND MOUNTED SIGNS

6 1094-1 GROUND-MOUNTED SIGN SUPPORTS

7 (A) Breakaway or Simple Steel Beam Sign Supports

8 Fabricators of breakaway or simple steel beam sign supports shall be AISC Category I
9 certified.

10 Steel supports for Type A and B ground mounted signs shall be galvanized rolled steel
11 sections, either breakaway or simple design, as required by the contract. Fabricate
12 supports from plates, W shapes, and S shapes, as required by the contract, and they shall
13 conform to ASTM A36. Splices in the supports will not be permitted. Perform
14 galvanizing before assembly that conforms to ASTM A123. Cutting steel supports to
15 length after they have been galvanized will not be permitted in new construction. The
16 support(s) shall be uniformly straight to within 1/8" tolerance for pieces less than 20 ft in
17 length, and 1/4" tolerance for pieces over 20 ft in length.

18 Fabricate high strength bolts, nuts and washers required for breakaway supports from
19 steel in accordance with ASTM A325 and galvanize in accordance with ASTM B695,
20 Class 55.

21 (B) Three Pound Steel U-Channel Posts

22 Make 3-lb steel U-channel posts out of rerolled rail steel or new billet steel, conforming
23 to the mechanical requirements of ASTM A499, Grade 60, and the chemical
24 requirements of ASTM A1, for rails having nominal weights of 91 lb/yd or greater.
25 Proportion the cross section so a moment of 1,450 ft-lb, applied to the cross section
26 normal to the flanges, will produce an extreme fiber stress no greater than 39,500 psi.
27 Use posts that weight 3 lb/lf. Punch or drill all posts with 3/8" diameter holes on the
28 centerline, spaced 1" on centers, starting 1" from the top and extending to the bottom of
29 the posts. Galvanize these posts after fabrication for the full length and total area in
30 accordance with ASTM A123. The zinc coating inside of the 3/8" diameter holes shall
31 not exceed Specification requirements enough to prevent a 5/16" diameter bolt from
32 freely passing through.

33 Use U-channel post sections of the same general configuration as that shown in the
34 contract, however minor variations may be considered acceptable by the Engineer
35 provided all other requirements are met.

36 (C) Two Pound Steel U-Channel Posts

37 Use 2-lb steel U-channel posts that are variable length galvanized steel, U-shaped
38 channel posts.

39 Fabricate the U-channel posts from steel meeting ASTM A1008 or ASTM A499, or
40 an approved alternate. The posts shall weigh 2 lb/lf, and be of the length necessary to
41 meet the erection requirements of the contract. Before galvanizing, punch or drill
42 3/8" diameter holes on 1" centers, beginning 1" from the top of the post, for a minimum
43 distance equal to the vertical dimension of the respective sign or mile marker. Galvanize
44 these posts after fabrication in accordance with ASTM A123. The zinc coating inside of
45 the 3/8" diameter holes shall not exceed Specification requirements enough to prevent
46 a 5/16" diameter bolt from freely passing through.

1 U-channel post sections shall be of the same general configuration as that shown in the
 2 contract, however, minor variations may be considered acceptable by the Engineer,
 3 provided all other requirements are met.

4 **(D) Steel Square Tube Posts**

5 Use steel square tube posts of variable length galvanized steel. The post shall be
 6 a minimum 14 gauge steel square tube. Before galvanizing punch or drill all posts with
 7 3/8" diameter holes on the centerline, spaced 1" on centers, starting 1" from the top and
 8 extending to the bottom of the posts.

9 Galvanize these posts after fabrication for the full length and total area in accordance
 10 with ASTM A123. G90 zinc coating shall not be accepted. The zinc coating inside of
 11 the 3/8" diameter holes shall not exceed Specification requirements enough to prevent
 12 a 5/16" diameter bolt from freely passing through.

13 Steel square tube sections shall be of the same general configuration as that shown in the
 14 contract, however, minor variations may be considered acceptable by the Engineer,
 15 provided all other requirements are met.

16 **(E) Wood Supports**

17 Wood supports shall conform to Articles 1082-2 and 1082-3.

18 **1094-2 RIVETS FOR SIGN OVERLAYS**

19 Rivets for sign overlays shall be 1/8" diameter aluminum rivets of the pull through type, and
 20 be approved by the Engineer. Submit for approval several samples of rivets, along with
 21 adequate descriptive catalog literature.

22 **SECTION 1096**
 23 **OVERHEAD SIGN STRUCTURES**

24 **1096-1 ALUMINUM OVERHEAD SIGN STRUCTURES**

25 Materials for aluminum overhead sign structures shall conform to Article 1092-1 and
 26 *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and*
 27 *Traffic Signals*. Where the Contractor proposes to use materials that are not covered by these
 28 references, such use will be contingent on the Engineer's approval of these materials.

29 **1096-2 STEEL OVERHEAD SIGN STRUCTURES**

30 Use Category I certified by the American Institute of Steel Construction Fabricators for steel
 31 overhead sign structures as required by Subarticle 1072-1(A). Use either structural carbon
 32 steel or structural low-alloy steel for steel overhead sign structures meeting *AASHTO LRFD*
 33 *Bridge Design Specifications*. Other steel may be used, subject to the approval of the
 34 Engineer. Structural steel that has been cold-rolled to increase the yield strength will be
 35 permitted. Mechanically galvanize all fasteners. Hot-dip galvanize all other components of
 36 the structural assembly after fabrication has been completed. The galvanizing shall meet
 37 ASTM B695, Class 55, for fasteners and ASTM A123 for other structural steel.

38 **1096-3 WELDING**

39 Perform all welding in the fabrication of the supports by AWS certified welders. Furnish
 40 a copy of the AWS certification for each welder used for fabrication. All welds shall be free
 41 of cracks, blow holes, slag, and other irregularities, and be wire brushed, sandblasted or
 42 otherwise cleaned.

43 Aluminum welding processes and procedures, shielding gases, preparation, weld quality,
 44 inspection and correction of welds, and the qualification of welding procedures, welders and
 45 welding operators will be governed by the AWS Structural Welding Code, D1.2.

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1 The welding of steel components, including structural details, filler metal, workmanship and
2 technique, qualification and inspection will be based on the applicable requirements of the
3 AWS Structural Welding Code, D1.1.

4 **SECTION 1098** 5 **SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEM** 6 **MATERIALS**

7 **1098-1 GENERAL REQUIREMENTS**

8 **(A) Qualified Products**

9 Furnish new equipment, materials, and hardware unless otherwise required. Inscribe
10 manufacturer's name, model number, serial number and any additional information
11 needed for proper identification on each piece of equipment housed in a case or housing.

12 ITS and Signals Qualified Products List (QPL) is available on the Department's website.

13 Certain signal and communications equipment, material and hardware shall be
14 pre-approved on the QPL by the date of installation. Equipment, material and hardware
15 not pre-approved when required will not be allowed for use on the project. Consult the
16 QPL web site to obtain pre-approval procedures.

17 **(B) Submittal Requirements**

18 Furnish a Type 3 material certification in accordance with Article 106-3. When
19 requested by the Department, provide additional certifications from independent testing
20 laboratories and sufficient data to verify item meets applicable Specifications. Ensure
21 additional certification states the testing laboratory is independent of the material
22 manufacturer and neither the laboratory nor the manufacturer has a vested interest in the
23 other.

24 Identify all proprietary parts in Contractor-furnished material. The Department reserves
25 the right to reject material that uses proprietary components not commercially available
26 through electronic supply houses.

27 For Contractor-furnished material listed on the QPL, furnish submittals in the format
28 defined by the QPL.

29 For Contractor-furnished material not on the QPL, furnish 3 copies of the equipment list
30 including 3 copies of catalog cuts. Identify proposed material on catalog cuts by
31 a reproducible means (highlighter pen does not transfer to copies). Ensure material lists
32 contain material description, brand name, manufacturer's address and telephone number,
33 stock number, size, identifying trademark or symbol and other appropriate ratings.

34 Do not fabricate or order material until receipt of the Engineer's approval.

35 **(C) Observation Period**

36 Warrant workmanship and Contractor-furnished equipment for a 30-day observation
37 period under the payment and performance bond from date of acceptance.

38 If workmanship or equipment fails during the 30-day observation period, repair or
39 replace with new equipment and begin a new 30-day observation period.

40 The observation period for this work is not part of the work to be completed by the
41 project completion date.

(D) Warranties

Unless otherwise required herein, provide manufacturer's warranties on Contractor-furnished equipment for material and workmanship that are customarily issued by the equipment manufacturer and that are at least 2 years in length from successful completion of the 30-day observation period. Include unconditional coverage for all parts and labor necessary or incidental to repair of defective equipment or workmanship and malfunctions that arise during warranty period.

Ensure all contractor-furnished equipment, including pieces and components of equipment, hardware, firmware, software, middleware, internal components and subroutines, which perform any date or time data recognition function, calculation or sequencing will support a four digit year format for at least 50 years.

Upon successful completion of the 30-day observation period, transfer manufacturer's warranties with proper validation by the manufacturer to the Department or its designated maintaining agency.

(E) Firmware Licensing and Upgrades

Provide the Department with a license to duplicate all programmable devices in equipment for maintenance and software upgrades. Provide binary or hexadecimal format files for each device that may be programmed by the Department. Ensure files are provided on PC compatible compact discs or other approved media.

Ensure firmware performance upgrades that occur during the contract period are available to the Department at no additional cost.

Make firmware upgrades that are developed to correct operating characteristics available to the Department at no additional cost until the warranty period expires.

(F) Plan of Record Documentation

Before final acceptance, furnish plan of record documentation of all fieldwork. Plan of record documentation will be subject to approval before final acceptance. Store documentation in a manila envelope placed in a weatherproof holder mounted within each cabinet or housing for easy access.

Except for standard bound manuals, bind all 8 1/2" x 11" documentation, including 11" x 17" drawings folded to 8 1/2" x 11", in logical groupings in either 3-ring or plastic slide-ring loose-leaf binders. Permanently label each grouping of documentation.

Provide manual, electrical schematic diagram, and cabinet wiring diagram for each control equipment cabinet and piece of equipment in cabinet. Place manuals and prints in weatherproof holder. For wiring diagrams and electrical schematic diagrams not bound into printed manuals, provide copies at least 22" x 34".

Provide Operator's Manuals containing detailed operating instructions for each different type or model of equipment. Ensure manuals contain instructions for possible modification to equipment.

Provide maintenance procedures manuals containing detailed preventive and corrective maintenance procedures for each different type or model of equipment.

Provide detailed wiring diagrams that include interconnection of equipment with pin-out configurations, pin functions, and cable part numbers. For communications systems, camera systems, video imaging loop emulator detection systems, intelligent transportation systems, closed loop signal systems and other computerized systems, provide 2 copies of system connection diagrams showing system interconnection cables and associated terminations.

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1 (G) Wire and Cable

2 Furnish wire and cable on reels. When requested by the Department, furnish samples of
3 wire and cable to the Department at no additional cost.

4 (H) Electrical Service

5 Furnish external electrical service disconnects with single pole 50 A inverse time circuit
6 breaker with at least 10,000 RMS symmetrical amperes short circuit current rating in
7 a lockable NEMA 3R enclosure. Ensure service disconnects are listed as meeting
8 UL Standard UL-489 and marked as being suitable for use as service equipment.
9 Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint
10 finish, light gray in color, to yield a minimum thickness of 2.4 mils. Provide ground bus
11 and neutral bus with at least 4 terminals with minimum wire capacity range of number 14
12 through number 4.

13 Furnish NEMA Type 3R meter base rated 100 A minimum that meets the requirements of
14 the local utility. Provide meter base with ampere rating of meter sockets based on
15 sockets being wired with insulated wire rated at least 167°F.

16 Furnish 4 terminal, 600 volt, single phase, 3 wire meter base with the following:

- 17 (1) Line, Load and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire,
- 18 (2) Ringed or Ringless Type, with or without bypass,
- 19 (3) Made of galvanized steel,
- 20 (4) Listed as meeting UL Standard UL-414, and
- 21 (5) Overhead or underground service entrance as specified.

22 Ensure meter bases have electrostatically applied dry powder paint finish, light gray in
23 color, with minimum thickness of 2.4 mils.

24 Furnish 1" watertight hub for threaded rigid conduit with meter base.

25 If meter base and electrical service disconnect are supplied in the same enclosure, ensure
26 assembly is marked as being suitable for use as service equipment. Ensure combination
27 meter and disconnect mounted in a pedestal for underground service is listed as meeting
28 UL Standard 231. Otherwise, ensure combination meter and disconnect is listed as
29 meeting UL Standard 67.

30 (I) Painting

31 Where painting of signal equipment cabinets, signal heads, signal poles, and pedestals is
32 required, apply paint at the factory. No field painting will be allowed except when paint
33 has been scratched or marred. In such cases, apply 2 field coats of the same color and
34 grade enamel as the original paint to the scratched or marred portions.

35 (J) Performance of Warranty Repair and Maintenance

36 Provide authorization to the Traffic Electronics Center of the North Carolina Department
37 of Transportation (NCDOT) to perform all warranty repairs after project acceptance. The
38 decision to perform warranty work at the Traffic Electronics Center by NCDOT
39 electronics technicians or to have warranty work performed by the vendor shall be at the
40 discretion of the State. Provide any training required by the manufacturer to authorize
41 the Traffic Electronics Center to perform warranty work and ensure manufacturer will
42 furnish parts to the Traffic Electronics Center for all warranty repairs at no cost to the
43 State. In addition, ensure the manufacturer agrees to provide prompt technical support to
44 the NCDOT electronics technicians for a period of one year after the end of the warranty
45 period at no cost to the State. Defective parts replaced under warranty by the Traffic
46 Electronics Center will be returned to the vendor at the vendor's request.
47 Provide schematics, part lists, and other documentation to perform bench repair to the

1 Traffic Electronics Center within 2 weeks upon request. The Department agrees not to
2 divulge any proprietary information in the schematics, part lists and other documentation
3 upon request from the vendor. After project acceptance and at the request of the State,
4 manufacturer shall perform warranty repairs to equipment which fails during the
5 warranty period at no cost to the State including freight costs to ship repaired equipment
6 back to the Traffic Electronics Center. Ensure all equipment is repaired and returned to
7 the Traffic Electronics Center within 21 calendar days of receipt by the manufacturer.

8 **1098-2 BACKPLATES**

9 Comply with ITE standard *Vehicle Traffic Control Signal Heads*. Provide backplates specific
10 to the manufacturer of the vehicle signal heads. Provide stainless steel fasteners and hardware
11 for attachment to signal head. Provide backplates that extend at least 5" from the vehicle
12 signal head outline. Ensure the backplate fills in the gaps between cluster-mounted vehicle
13 signal sections (5-section vehicle signal heads). A 1/4" maximum gap between vehicle signal
14 head and backplate, as viewed from the front, will be allowed.

15 Fabricate metallic backplates for vehicle signal heads from sheet aluminum at least
16 0.05" thick. Provide backplates painted an alkyd urea black synthetic baking enamel with
17 minimum gloss reflectance that meets Federal Specification MIL-E-10169, Instrument Black.

18 Provide polycarbonate or vacuum formed ABS plastic backplates that are black on both the
19 front and back sides with a consistent color throughout the entire piece for each backplate.
20 Provide backplates that contain UV inhibitors and stabilizers for protection against
21 UV degradation. Provide backplates that have a minimum tensile stress at yield of 5,300 psi
22 at 73°F and meet UL Standard 94. Ensure polycarbonate backplates have a minimum
23 thickness of .100" with one side dull black and the other side semi-gloss black. Ensure
24 vacuum formed ABS plastic backplates have a minimum thickness of 0.125" with a hair cell
25 finish on the front side and a smooth finish on the back side.

26 **1098-3 MESSENGER CABLE**

27 Comply with **ASTM A475** for extra high strength grade wire strand, Class A zinc coating.
28 Fabricate messenger cable from seven steel wires twisted into a single concentric strand.

29 **1098-4 RISER SEALING DEVICES**

30 Furnish appropriately sized clamp-on aluminum weatherheads for electrical control and
31 power cables.

32 Furnish heat shrink tubing for the installation of fiber-optic or coaxial cable in a new riser.
33 Ensure the heat shrink tubing is made of modified polyolefin and includes a hot-melt
34 adhesive. Provide tubing that has a length of at least 5" before heating. Ensure the heat
35 shrink tubing will provide a watertight fit around individual cables and outer wall of the riser
36 after heat is applied in accordance with the manufacturer's instructions.

37 Furnish heat shrink tubing retrofit kits for the installation of fiber optic cable or coaxial cables
38 to an existing riser with existing cables. Ensure the heat shrink material is made of modified
39 polyolefin and is supplied in a flat sheet design. Ensure the kit contains an apparatus to
40 secure both ends of the flat sheet together to form a tube shaped cylinder. Ensure the securing
41 apparatus is flexible to the point that it will allow the heat shrink material to conform to the
42 shape and dimensions of the riser and cables once heat is applied and will not separate during
43 the heating process. Provide heat shrink tubing retrofit kits with a hot-melt adhesive. Provide
44 the flat sheet heat shrink material that has a minimum length of 5" prior to heating. Ensure
45 the heat shrink tubing retrofit kit provides a watertight fit around individual cables and outer
46 wall of the riser after heat is applied in accordance with the manufacturer's instructions.

47 **1098-5 JUNCTION BOXES**

48 **(A) General**

49 Comply with Article 1091-5.

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1 (B) Standard Size Junction Boxes

2 Provide standard size junction boxes and covers with minimum inside dimensions of
3 16"(l) x 10"(w) x 10"(d).

4 (C) Oversized Junction Boxes

5 Provide oversized junction boxes and covers with minimum inside dimensions
6 of 30"(l) x 15"(w) x 24"(d).

7 1098-6 POLE LINE HARDWARE

8 Provide universal grade strandvises used for extra high strength steel messenger cable.

9 Provide other pole line hardware constructed of hot-dipped galvanized steel conforming to
10 ASTM A153.

11 Provide machine bolts, eyebolts and thimble eye bolts with minimum tensile strength of
12 12,400 lb. Provide hot-dipped galvanized nuts, 3" x 3" curved square washers and
13 thimbleyelets.

14 Provide suspension clamp fabricated from hot-dipped galvanized steel with minimum length
15 of 5 3/4". Ensure clamp has a groove rated for the messenger cable size it is intended to
16 secure. Provide J-hook fabricated from 3/8" thick hot-dipped galvanized steel flat or oval
17 stock with sufficient hook radius to cradle 11/16" diameter cable. Provide two 1/2" diameter
18 hot-dipped galvanized bolts and nuts to tighten the clamp around the messenger cable.
19 Provide one 5/8" diameter hot-dipped galvanized bolt of sufficient length to attach J-hook and
20 clamp to the wood pole with a 3" x 3" curved square washer and double nuts.

21 Provide 3-bolt clamp fabricated from hot-dipped galvanized steel with minimum length
22 of 5 3/4". Ensure clamp has 2 parallel grooves rated for the messenger cable size it is
23 intended to secure. Provide three 5/8" diameter hot-dipped galvanized bolts and nuts to
24 tighten the clamp around the messenger cable.

25 Provide parallel groove clamp consisting of high strength, high conductivity non-copper
26 bearing aluminum alloy clamp halves with interlocking fingers to prevent mismatch. Ensure
27 clamp halves have molded grooves to secure #8-1/0 AWG stranded copper wires. Provide
28 clamps with grooves prefilled with antioxidant joint compound. Provide 3/8" hex head,
29 square shank, galvanized steel bolt with galvanized steel lock washer and nut.

30 Provide 1/2" and 3/4" wide, .030" thick Type 316 stainless steel straps with Type 316 stainless
31 steel buckles.

32 Provide either 0.05" x 0.30" aluminum wrapping tape or 0.06" diameter Type 316 stainless
33 steel lashing wire for lashing cables to messenger cable. Ensure aluminum wrapping tape is
34 1350 alloy, O-temper, with 12,800 psi tensile strength. Use 0.045" diameter Type 316
35 stainless steel lashing wire to lash fiber-optic communications cable to messenger cable.

36 Provide hot-dipped galvanized steel clamp with groove sized for 1/4" to 3/8" messenger cable
37 for securing lashing wire(s) to messenger cables at ends of each spiraled run. Ensure clamp
38 hardware is hot-dipped galvanized steel.

39 1098-7 GUY ASSEMBLIES

40 Furnish guy assemblies with anchor assemblies, guy cable and guy cable guard.

1 Provide anchor assemblies with all miscellaneous hardware consisting of either expanding
 2 anchor with rod and triple-eye attachment, screw anchor with extension rod and triple-eye
 3 attachment, or expanding rock anchor with triple-eye attachment. Ensure anchor assembly
 4 size is adequate for site conditions. Provide rods constructed of hot-dipped galvanized steel
 5 sized according to the soil bearing conditions in the area. Provide triple-eye guy attachments
 6 constructed of hot-dipped galvanized steel. Anchor assemblies with double-strand eyes may
 7 be used instead of those with the triple-eye feature when only one guy cable is to be attached.
 8 Ensure anchor assemblies are 7 ft minimum in length.

9 For type of anchor assembly furnished, ensure the following:

10 **(A) Expanding Anchor**

11 Provide steel construction with protective paint or heat shrink of 6 mil plastic to protect
 12 metal during shipping and storage.

13 **(B) Screw Anchor**

14 Provide hot-dipped galvanized steel construction.

15 **(C) Expanding Rock Anchors**

16 Provide malleable iron and rust-resisting paint construction.

17 Provide 3-bolt clamp to match messenger cable size.

18 Provide full round guy cable guards that are 8 ft in length and constructed of UV stabilized,
 19 high impact, bright yellow HDPE.

20 Provide guy cables consisting of messenger cable of the same size as the largest sized
 21 messenger cable to be guyed. Comply with Article 1098-3.

22 **1098-8 INDUCTIVE DETECTION LOOPS**

23 **(A) Loop Sealant**

24 Provide loop slot sealant that completely encapsulates loop wire when installed according
 25 to manufacturer's instructions. Provide loop sealant that does not generate temperatures
 26 greater than 220°F. Ensure sealant bonds with asphalt and concrete pavement saw slots
 27 so sealant and encapsulated loop wire do not come out of slot. Ensure sealant is self-
 28 leveling, but with sufficient viscosity to prevent exit from saw slot when installed along
 29 a 10% grade.

30 Provide sealant that protects loop wire by preventing the entrance of dirt, water, rocks,
 31 sticks, and other debris into saw slot, and is resistant to traffic, water, gasoline, chemical
 32 and chemical fumes, mild alkalis, oils and mild acids. Ensure sealant will not be affected
 33 by water and sealant does not chemically interact with pavement and loop wire
 34 insulation.

35 Ensure loop sealant has sufficient flexibility to permit expected pavement expansion and
 36 contraction due to weather and to permit pavement movement due to traffic without
 37 cracking for a temperature range of -40 to 160°F.

38 Provide sealant with a usable life of at least ten minutes once mixed, when the ambient
 39 temperature is 75°F. Ensure sealant dries to tack free state in less than 2 hours, and does
 40 not flow within or out of saw slot after exposed surface has become tack free. Tack free
 41 time will be determined by testing with a cotton ball until no sealant adheres to cotton
 42 ball and no cotton adheres to sealant.

43 Ensure 2 part sealant cures within 48 hours to attain 95% of published properties for the
 44 cured material.

45 Ensure one part sealant cures within 30 days to attain 95% of published properties for the
 46 cured material.

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1 (B) Loop Wire

2 Provide loop wire composed of 19-strand conductor insulated by a cross-linked
3 polyethylene compound. Ensure insulated conductors are completely encased in tubes of
4 low density polyethylene compound. Print manufacturer's name, manufacture year and
5 any applicable part number on encasing tube at intervals of 2 ft or less.

6 Provide number 14 AWG copper conductors fabricated from 19 strands that comply with
7 ASTM B3 before insulating. Ensure stranded conductors use either concentric or bunch
8 stranding and comply with circular mil area and physical requirements of ASTM B8 or
9 ASTM B174 for bunch stranding.

10 Provide insulating compound that is cross-linked thermosetting black polyethylene in
11 accordance with ASTM D2655. Ensure insulation is applied concentrically about
12 conductor. Provide insulation thickness not less than 0.026" at any point and minimum
13 average thickness of 0.030" as measured by UL Standard 62.

14 Ensure insulation of finished conductor will withstand application of a 60 Hertz or
15 3,000 Hertz, 7,500 volt (RMS) essentially sinusoidal spark test potential as specified in
16 UL Standard 83.

17 Provide insulated conductors that are factory-installed in a protective encasing tube that
18 complies with the following:

19 Encasing tube fabricated of polyethylene compound conforming to ASTM D1248 for
20 Type I, Class C, Grade E5. Provide a minimum inside diameter of 0.150". Provide
21 a wall thickness of 0.040" ± 0.010". Provide an outside diameter of 0.240" ± 0.010".

22 (C) Conduit

23 Comply with Subarticle 1091-3(C) for PVC conduit.

24 1098-9 LEAD-IN CABLE

25 Furnish lead-in cable with 2 conductors of number 14 AWG fabricated from stranded tinned
26 copper that complies with IMSA Specification 50-2 except as follows:

27 (A) Ensure conductor is twisted with a maximum lay of 2.0" resulting in at least 6 turns per
28 foot.

29 (B) Provide a ripcord to allow cable jacket to be opened without using a cutter.

30 Provide length markings in a contrasting color showing sequential feet and within 1% of
31 actual cable length. Ensure character height of the markings is approximately 0.10".

32 1098-10 FIBER-OPTIC CABLE

33 (A) SMFO Communications Cable

34 Furnish single mode fiber-optic cable manufactured into a loose buffer tube design,
35 installed around a central strength member where the cable complies with
36 RUS CFR 1755.900 and ICEA 640 requirements. Ensure the Manufacture is ISO 9001
37 and TL9000 registered and that the manufacturer's cable is RUS listed. The operating
38 temperature range of the cable shall be -40°F to +158°F.

39 Furnish individual fibers manufactured from silica and dopant materials with each fiber
40 having a color coated finish that is compatible with local injection detection (LID)
41 devices. Distinguish each fiber from others by color coding that meets EIA/TIA-598.
42 Furnish single mode fiber that does not exceed attenuation ratings of 0.25 dB/km at
43 1550 nm and 0.35 dB/km at 1310 nm and complies with ITU G.652D and
44 IEC 60793-2-50 Type B.1.3 industry standards for low water peak, single mode fiber.
45 Provide fibers that are useable and with a surface, sufficiently free of imperfections and
46 inclusions to meet optical, mechanical and environmental requirements.

1 Ensure the core central strength member is a dielectric glass reinforced rod and that the
 2 completed cable assembly has a maximum pulling rating of 600 lbf during installation
 3 (short term) and 180 lbf long term installed.

4 Construct buffer tubes (nominal size of 2.5 mm) manufactured from a polypropylene
 5 copolymer material to provide good kink resistance and allows the buffer tube to
 6 maintain flexibility in cold temperature over the expected lifetime of the cable. Ensure
 7 that buffers tubes contain no more than 12 fibers per buffer tube unless specified
 8 otherwise, and that all buffer tubes are filled with a water blocking gel or water swellable
 9 material. Construct the cable such that the buffer tubes are stranded around the central
 10 strength member in a reverse oscillating arrangement to allow for mid-span entry.
 11 Distinguish each buffer tube from others by color coding that meets EIA/TIA-598. Use
 12 filler tubes to maintain a circular cross-section of the cable. Ensure the filler tubes are the
 13 same nominal size as the buffer tubes of 2.5 mm. Apply binders (water swellable yarn,
 14 kevlar, etc.) with sufficient tension to secure buffer tubes and filler tubes to the central
 15 member without crushing the buffer tubes. Ensure that binding material is
 16 non-hygroscopic, non-wicking and dielectric with low shrinkage. Ensure the binders are
 17 of a high tensile strength that is helically stranded evenly around cable core.

18 Ensure the cable core is protected from the ingress of moisture by a water swellable
 19 material or that is filled with a water blocking compound that is non-conductive. Ensure
 20 the water swellable material (when activated) or the water blocking compound is free
 21 from dirt and foreign matter and is removable with conventional nontoxic solvents.
 22 Furnish at least one ripcord to aid in the process of removing the outer jacket. Furnish
 23 the outer jacket constructed of a medium-density polyethylene material to provide
 24 reduced friction and enhanced durability. Ensure the polyethylene material contains
 25 carbon black to provide UV protection and does not promote the growth of fungus.
 26 Ensure the cable jacket is free of slits, holes or blisters and the nominal outer jacket
 27 thickness is ≥ 0.050 ".

28 Ensure the completed cable assembly contains identification markings printed along the
 29 outside cover of the jacket every 2 ft. Ensure the character height of the markings is
 30 approximately 0.10". Provide length markings in sequential feet and within 1% of actual
 31 cable length.

32 Mark each cable with the following:

- 33 (1) Sequential length marks in feet as specified
- 34 (2) The name of the manufacturer
- 35 (3) "OPTICAL CABLE"
- 36 (4) Month/year of manufacture
- 37 (5) Number(s) of and type(s) of fibers
- 38 (6) Cable ID Number for product traceability

39 **(B) Drop Cable**

40 Furnish drop cable meeting the material requirements listed in Subarticle 1098-10(A)
 41 with the exceptions herein to provide communications links between splice enclosures
 42 and through interconnect centers. Furnish drop cable containing at least 6 individual
 43 fibers.

44 Furnish drop cable that complies with RUS-CFR 1755.900 and is RUS listed. Ensure
 45 each drop cables has the same operating characteristics as the SMFO cable it is to be
 46 coupled with.

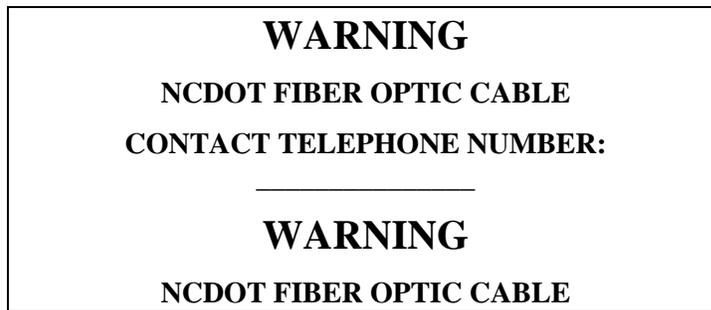
47 On one end of cable furnish six ST-PC connectors for termination on connector panel in
 48 equipment cabinet. Provide either factory assembled drop cables with ST-PC connectors
 49 or field installed connectors. No connectors are required for drop cables running from
 50 one splice enclosure directly to another splice enclosure.

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1 Ensure attenuation of drop cable at 1310 nm does not exceed 0.4 dB/km and the
2 attenuation at 1550 nm does not exceed 0.3 dB/km. Ensure attenuation loss for complete
3 drop cable assembly does not exceed a mean value of 1.5 dB.

4 (C) Communications Cable Identification Markers

5 Furnish yellow communications cable identification markers that are resistant to fading
6 when exposed to UV sources and changes in weather. Use markers designed to coil
7 around fiber-optic cable that do not slide or move along the surface of the cable once
8 installed. Ensure exposure to UV light and weather does not affect the markers natural
9 coiling effect or deteriorate performance. Provide communications cable wraps that
10 permit writing with an indelible marking pen and contain the following text in black:



17 **Figure 1098-1. Communication Cable Identification Marker.**

18 Overall Marker Dimensions: 7"(l) x 4"(w)

19 Lettering Height: 3/8"for WARNING, 1/4" for all other lettering

20 Submit a sample of proposed communications cable identification markers to the
21 Engineer for approval before installation.

22 (D) Fiber-Optic Cable Storage Guides

23 Furnish fiber-optic storage guides (snowshoes) that are non-conductive and resistant to
24 fading when exposed to UV sources and changes in weather. Ensure snowshoes have
25 a captive design such that fiber-optic cable will be supported when installed in the rack
26 and the minimum bending radius will not be violated. Provide stainless steel attachment
27 hardware for securing snowshoes to messenger cable and black UV resistant tie-wraps for
28 securing fiber-optic cable to snowshoe. Ensure snowshoes are stackable so multiple
29 cable configurations are possible.

30 1098-11 FIBER-OPTIC SPLICE CENTERS

31 (A) Interconnect Center

32 Furnish compact, modular interconnect centers designed to mount inside equipment
33 cabinets. Design and size interconnect centers to accommodate all fibers entering
34 cabinets.

35 Provide splice trays that hold, protect, and organize optical fibers, and secure fibers inside
36 splice tray. Design and size splice trays to be dielectric, to accommodate all fibers
37 entering splice tray, and to provide sufficient space to prevent microbending of optical
38 fibers. Provide connector panels with ST-type connectors.

39 Furnish SMFO pigtails with each interconnect center. Provide pigtails containing
40 connector panels that are no more than 6 ft in length with a factory assembled PC-ST
41 connector on one end. Ensure SMFO pigtails meet the operating characteristics of the
42 SMFO cable with which it is to be coupled.

43 Furnish SMFO jumpers that are at least 3 ft in length with factory assembled PC-ST
44 connectors on each end. Ensure SMFO jumpers meet the operating characteristics of the
45 SMFO cable with which it is to be coupled.

(B) Splice Enclosure

Furnish splice enclosures that are re-enterable using a mechanical dome-to-base seal with a flash test valve, and are impervious to the entry of foreign material (water, dust, etc.). Ensure enclosures are manufactured so as to be suitable for aerial, pedestal, buried, junction box and manhole installation.

Provide enclosures with at least one over-sized oval port that will accept 2 cables and with at least 4 round ports (for single cables) that will accommodate all cables entering enclosure. Provide heat shrink cable shields with enclosure to ensure weather tight seal where each cable enters enclosure.

Within enclosures, provide enough hinged mountable splice trays to store the number of splices required, plus the capacity to house six additional splices. Provide a fiber containment basket for storage of loose buffer tubes expressed through the enclosure. Ensure enclosures allow sufficient space to prevent microbending of buffer tubes when coiled.

Provide splice trays that hold, protect, and organize optical fibers, and secure fibers inside splice tray. Provide splice trays that are dielectric.

1098-12 FIBER-OPTIC TRANSCEIVERS

Furnish shelf-mounted, modular, single mode fiber-optic transceivers that transmit and receive optical signals over a fiber-optic communications medium of 2 fibers and interface with equipment cabinets (signal controller, dynamic message signs, etc.). Ensure transceivers are asynchronous in operation. Ensure transceivers are capable of operating up to 5 miles without boosting signal and without distortion. Ensure transceivers are switch selectable for either local or master operation.

Do not provide transceivers internal to system equipment. Provide identical transceivers at all locations capable of being interchanged throughout system.

Provide LEDs on the front panel of transceivers for power, and transmitting and receiving indications. Comply with the following:

Property	Requirement
Input Power	115 VAC
Minimum Loss Budget	12 dB with corresponding receiver
Operating Wavelength	1310 or 1550 nm
Optical Connector	ST
Signal Connector	Female Plug Type DB9 or DB25
Temperature Range	0 to 150°F

Ensure modems operate in one of the following topologies:

Drop and Repeat Transceivers: Furnish transceivers that transmit and receive data in drop-and-repeat poll-response data network mode with EIA/TIA-232, EIA/TIA-422 and EIA/TIA-485 protocols.

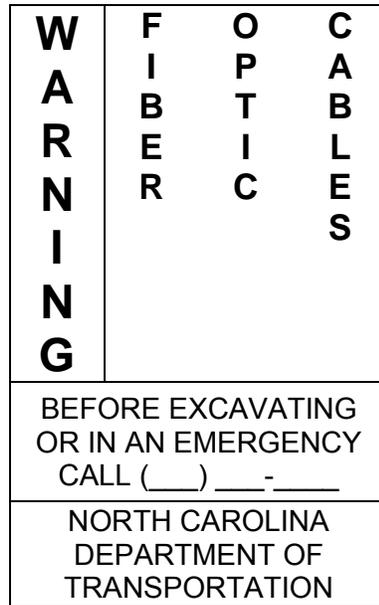
Self-Healing Ring Transceivers: Furnish transceivers that transmit and receive data in a drop-and-insert poll-response data network mode with EIA/TIA-232, EIA/TIA-422 and EIA/TIA-485 protocols. Ensure transceiver operates in a Self-Healing Ring Network Architecture.

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1 1098-13 DELINEATOR MARKERS

2 Furnish tubular delineator markers, approximately 6 ft long, and constructed of
3 Type III HDPE material. Provide delineator assemblies that are ultraviolet stabilized to help
4 prevent components from color fading, warping, absorbing water, and deterioration with
5 prolonged exposure to the elements. Provide delineators designed to self-erect after being
6 knocked down or pushed over. Provide orange delineator posts.

7 Provide text, including division contact number, hot stamped in black on a yellow reflective
8 background material that will not fade or deteriorate over time. Provide delineator markers
9 with nominal message height of 15" that contain the text in Figure 1098-2 visible from all
10 directions approaching the assembly.



11 **Figure 1098-2. Delineator Marker.**

12 **1098-14 PEDESTALS**

13 Furnish pedestal assemblies with foundations that conform to the latest edition of the
14 *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and*
15 *Traffic Signals* in effect on the date of project advertisement. Refer to *Roadway Standard*
16 *Drawings* No. 1743 for structural design specifications for each type of pedestal.

17 **(A) Pedestal Shaft**

18 Furnish one piece pedestal shafts fabricated from either aluminum or galvanized steel
19 pipe with a uniform pipe outer diameter of 4.5" and of the lengths specified for the type
20 of pedestal shown on *Roadway Standard Drawing No. 1743*. Refer to Article 1743-2 for
21 pedestal type descriptions.

22 For Type I (pedestrian pushbutton pedestals) and Type II (normal-duty pedestals), furnish
23 shafts constructed from schedule 40 extruded aluminum pipe that conforms to Aluminum
24 Association Alloy 6063-T6 with a tensile strength of 30 KSI and a minimum wall
25 thickness of 0.237". Aluminum conduit will not develop the necessary strength required
26 and is not allowed. Thread and deburr in accordance with American National Standard
27 Pipe Threads, NPT (ANSI B2.1). Finish the exterior with a rough surface texture
28 consisting of a uniform grain pattern that is perpendicular to the axis of the pipe along the
29 full pipe length. Unless otherwise specified, do not use galvanized steel pipe for Type I
30 and Type II pedestal shafts.

1 For Type III (heavy-duty pedestals), furnish schedule 120 galvanized steel pipe that
 2 conforms to ASTM A53. Provide an 11" square by 1" thick steel base plate with
 3 minimum yield strength of 36 ksi that conforms to ASTM A36. Fabricate the base plate
 4 with four equally spaced bolt holes on an 11" bolt circle. Orient the bolt holes in the
 5 corners of the plate. Size the holes to accommodate 1" diameter machine bolts. Weld the
 6 pedestal shaft to the center of the base plate using a socket connection. Provide
 7 circumferential fillet welds at the top and bottom of the base plate. Perform all welding
 8 in accordance with the latest AWS Code. Hot-dip galvanize the pedestal shaft and base
 9 plate assembly after fabrication in accordance with ASTM A123. Unless otherwise
 10 specified, do not use aluminum pipe for Type III pedestal shafts.

11 (B) Transformer Bases

12 Furnish transformer bases for each type of pedestal shown on *Roadway Standard*
 13 *Drawings* No. 1743 fabricated from aluminum that meets Aluminum Association
 14 Alloy 356 or equivalent, and that are designed to break upon impact in accordance with
 15 AASHTO requirements. Submit FHWA certification for each type of transformer base
 16 that reflects compliance with NCHRP 350. For use in grounding and bonding, provide
 17 a 0.5" minimum diameter, coarse thread hole cast into transformer base located inside
 18 base and oriented for easy access.

19 Provide a minimum access opening for all transformer bases of 8" x 8" with an access
 20 door that is attached with stainless steel hinges on one side of the transformer base.
 21 Provide a 1/4" x 3/4" long stainless steel vandal proof screw to secure access door.

22 For Type I (pedestrian pushbutton pedestals) and Type II (normal-duty pedestals),
 23 provide overall base dimensions of 15" (l) x 13 3/4" (w) x 13 3/4" (d) for square bases
 24 and 14" (l) x 16 1/2" (w) x 16 1/2" (d) for octagonal bases. Provide a threaded opening at
 25 the top of the base to receive a 4" NPT pipe shaft. Fabricate the bottom of the
 26 transformer base with 4 equally spaced holes or slots for a 12" bolt circle to secure the
 27 entire assembly to the concrete foundation.

28 For Type III (heavy-duty pedestals), provide square bases with overall dimensions of
 29 17" (l) x 13" (w) x 13" (d). Fabricate the top of the transformer base with 4 equally
 30 spaced holes or slots for an 11" bolt circle to attach the pedestal shaft. Size the holes or
 31 slots to accommodate 1" diameter machine bolts. Fabricate the bottom of the transformer
 32 base with 4 equally spaced holes or slots for a 12" bolt circle to secure the entire
 33 assembly to the concrete foundation. Size the holes or slots to accommodate 1" diameter
 34 anchor bolts. Provide the following mounting hardware for heavy-duty pedestals:

- 35 (1) Four 1" diameter by 3 1/2" long machine bolts (ASTM F593), with heavy hex nuts
 36 (ASTM A563 Grade DH, or A 194 Grade 2H), and thick flat washers, and lock
 37 washers (ASTM F436) per pedestal assembly. Galvanize in accordance with
 38 ASTM A153.
- 39 (2) Three heavy hex nuts (ASTM A563 Grade DH, or A194 Grade 2H), 2 thick flat
 40 washers, and one lock washer (ASTM F436) for each anchor bolt. Galvanize in
 41 accordance with ASTM A153.
- 42 (3) Six minimum slotted stainless steel shims of necessary thickness for leveling per
 43 pedestal assembly.

44 (C) Anchor Bolts

45 For each pedestal, provide 4 anchor bolts in accordance with ASTM F1554, Grade 55, of
 46 the size and length specified in *Roadway Standard Drawings* No. 1743 each having one
 47 heavy hex nut with 2 washers at the top and 2 heavy hex nuts with one washer at the
 48 bottom. Provide anchor bolts with coarse threads at 10 threads per inch for a minimum
 49 length of 4" from each end of the bolt. All thread anchor rods may be used.

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1 Ensure anchor bolts are hot-dipped galvanized in accordance with ASTM A153 with
2 completely galvanized nuts and washers. Provide hex nuts with coarse threads. Ensure
3 hex nuts are in accordance with ASTM A563 Grade DH, ASTM A194, Grade 2H or
4 equivalent. Ensure washers are in accordance with ASTM F436 or equivalent. As a
5 minimum, provide standard size washers.

6 (D) Pedestal Cap

7 Furnish a 4 1/2" outside diameter slip fit domed pedestal top cap for each pedestal
8 assembly designed to fit over the outside of the pedestal shaft. Fabricate the cap from
9 aluminum that meets Aluminum Association Alloy 356. Ensure the cap provides
10 3 equally spaced stainless steel set screw fasteners to secure the cap to the pedestal shaft.

11 (E) Pole Flange Base for 4 1/2" Pipe

12 Furnish a flange base with cover for use with Type I (pedestrian pushbutton pedestals)
13 and Type II (normal-duty pedestals) only. Flange bases are non breakaway supports that
14 are to be used with a breakaway bolt system for AASHTO compliance for breakaway
15 structures. Provide aluminum or steel flange bases with a minimum 7.5" diameter bolt
16 circle. Ensure bases are either continuously welded to shafts or threaded to receive
17 shafts. Each base should be designed to accommodate either three or four 1/2" bolts
18 equally spaced on the bolt circle to receive breakaway anchors. Provide NPT threads on
19 the internal opening of the flange base through the full length of the flange base with
20 locking set screws at the top of the base to receive a 4" NPT pipe shaft.

21 Fabricate aluminum flange bases that meet Aluminum Association Alloy 356
22 requirements for architectural bases. Fabricate steel flange bases that meet ASTM A36.

23 Do not use flange bases for Type III pedestals.

24 (F) Breakaway Anchors

25 Furnish single or double neck omni-directional breakaway anchor bolt coupling systems
26 for use with Type I (pedestrian pushbutton pedestals) and Type II (normal-duty pedestals)
27 only. Use breakaway anchors that are FHWA certified to be compliant with NCHRP
28 Report 350 as an alternative to transformer bases. Use with non breakaway pole flange
29 bases. Use 1/2" diameter bolts for pushbutton posts and 3/4" bolts for normal-duty
30 pedestals. Fabricate from steel with a minimum yield strength of 55 KSI. Galvanize in
31 accordance with ASTM A153. Do not use breakaway anchors with Type III pedestals, or
32 in conjunction with breakaway transformer bases.

33 (G) Foundation

34 Install pedestal foundations of the type and size shown on *Roadway Standard Drawings*
35 No. 1743.04 Furnish Class A minimum concrete that conforms to Article 1000-4.

36 Provide reinforcing steel that conforms to the applicable parts of Section 1070.

37 1098-15 SIGNAL CABINET FOUNDATIONS

38 Provide foundations with a minimum pad area that extends 24" from front and back of cabinet
39 and 3" from sides of cabinet.

40 Furnish cabinet foundations with chamfered top edges. Provide minimum Class B concrete.

41 Provide preformed cabinet pad foundations with 7"(l) x 18"(w) minimum opening for the
42 entrance of conduits. For precast signal cabinet foundations, include steel reinforcement to
43 ensure structural integrity during shipment and placing of item. Include four 3/4" coil thread
44 inserts for lifting. Comply with Article 1077-16.

1098-16 CABINET BASE ADAPTER/EXTENDER

Fabricate base adapters and extenders from the same materials and with the same finish as cabinet housing. Fabricate base adapter and extender in the same manner as controller cabinets, meeting all applicable specifications called for in Section 6.7 of CALTRANS TEES. Provide base adapters and extenders a height of at least 12".

1098-17 BEACON CONTROLLER ASSEMBLIES**(A) General**

Furnish all cabinets with a solid state flasher that meets NEMA TS-2-2003. Encapsulate flasher components as necessary. Connect flasher to provide beacon operation as specified.

Submit drawings showing dimensions, location of required equipment and mechanisms, cabinet electrical diagrams, part numbers and descriptions of required equipment and accessories to the Engineer. Provide certification to the Engineer that materials used in cabinet construction meet these Specifications.

Furnish unpainted, natural, aluminum cabinet shells that comply with Section 7 of NEMA TS-2-2003. Ensure all non-aluminum hardware on cabinet is stainless steel or Department approved non-corrosive alternate. Provide roof with slope from front to back at a minimum ratio of 1" drop per 2 ft. Ensure each exterior cabinet plane surface is constructed of a single sheet of seamless aluminum. Ensure all components are arranged for easy access during servicing. When modular in construction, provide guides and positive connection devices to ensure proper pin alignment and connection.

Provide 20 mm diameter radial lead UL-recognized metal oxide varistors (MOV) between each field terminal and ground bus. Electrical performance is outlined in Table 1098-2.

**TABLE 1098-2
PROPERTIES OF SURGE PROTECTOR**

Property	Requirement
Maximum Continuous Applied Voltage at 85°C	150 VAC (RMS) 200 VDC
Maximum Peak 8x20µs Current at 85°C	6500 A
Maximum Energy Rating at 85°C	80 J
Voltage Range 1 mA DC Test at 25°C	212 - 268 V
Max. Clamping Voltage 8x20µs, 100A at 25°C	395 V
Typical Capacitance (1 MHz) at 25°C	1,600 pF

Provide beacon controller assemblies equipped with terminal blocks (strips) for termination of all field conductors and all internal wires and harness conductors. Terminate all wires at terminals. Ensure all field terminals are readily accessible without removing equipment and located conveniently to wires, cables, and harnesses to be connected. Ensure terminals are not located on under side of shelves or at other places where they are not readily visible or where they may present a hazard to personnel who might inadvertently touch them. Provide terminal blocks made of electrical grade thermoplastic or thermosetting plastic. Ensure each terminal block is of closed back design and has recessed-screw terminals with molded barriers between terminals. Ensure each terminal consists of 2 terminal screws with removable shorting bar between them. Ensure each terminal block is labeled with a block designation and each terminal is labeled with a number. Ensure all terminal functions are labeled on terminal blocks. Provide labels that are visible when terminal block is fully wired. Show labels on cabinet wiring diagrams. Ensure terminals serving similar functions are grouped together.

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1 Connect each conductor, including unused conductors, within or entering cabinet to
2 a terminal using crimped spade lugs. Place no more than 2 conductors on any single
3 terminal screw. Terminations to back panel may be soldered. Do not use quick
4 connectors or barrel connectors. Make all connections at terminals. Do not make in-line
5 splices.

6 Ensure outgoing circuits have same polarity as line side of power supply. Ensure
7 common return has same polarity as grounded conductor (neutral) of power supply.

8 Neatly package all wiring. Dress harnesses by lacing, braiding, or tying with nylon tie
9 wraps at closely spaced intervals. Attach wires, cables, or harnesses to cabinet walls for
10 support or to prevent undue wear or flexing. Use nylon tie straps or metal clamps with
11 rubber or neoprene insulators. Screw these attachment devices to cabinet. Do not use
12 stick-on clamps or straps.

13 Tag AC+, AC-, chassis ground, and flasher circuit conductors with non-fading,
14 permanent sleeve labels at conductor ends at terminals or use color-coded wire. Ensure
15 sleeve labels tightly grip conductors. Alternatively, use hot stamped labels on internal
16 conductor insulation at intervals of no greater than 4". Ensure label legends are
17 permanent.

18 Ensure all jumpers are wire conductors or metal plates. Do not use printed circuit back
19 panels or back panels using wire tracks as jumpers.

20 Lay out all equipment and components for ease of use and servicing. Ensure equipment
21 controls can be viewed and operated without moving or removing any equipment.
22 Ensure there is access to equipment or components for servicing without removing any
23 other equipment or components. Removal of equipment is acceptable to access fan or
24 thermostat. Ensure equipment can be removed using only simple hand tools. Ensure
25 layout of equipment and terminals within the various cabinets furnished is identical from
26 cabinet to cabinet, unless otherwise approved.

27 Mount equipment using harnesses with suitable multipin (or similar) connectors. Design
28 or key all equipment to make it physically impossible to connect unit to wrong connector.
29 Ensure that functionally equivalent equipment is electrically and mechanically
30 interchangeable.

31 Equip vents with standard-size, replaceable filters or, if located where they can easily be
32 cleaned, permanent filters.

33 **(B) Type F1 Cabinet**

34 Provide dual-circuit flasher and 20-amp inverse time circuit breaker with at least
35 10,000 RMS symmetrical amperes short circuit current rating. Install one insect-resistant
36 vent on bottom and one on top on opposite wall to facilitate airflow.

37 **(C) Type F2 Cabinet**

38 Provide 20" high x 16" wide x 12" deep cabinet, dual-circuit flasher, 20-amp inverse time
39 circuit breaker with at least 10,000 RMS symmetrical amperes short circuit current rating,
40 and solid state time switch. Provide filtered power to time switch. Install one insect-
41 resistant vent on each side of cabinet at the bottom to facilitate airflow.

42 **(D) Type F2 and F3 Cabinet – Surge Protection and Documentation**

43 Furnish and install a power line surge protector in the service power. Provide a 2-stage
44 power line surge protector that allows connection of the radio frequency interference
45 filter between stages of the device. Ensure device has a maximum continuous current
46 rating of at least 10 A at 120 V. Ensure device can withstand at least 20 peak surge
47 current occurrences at 20,000 A for an 8x20 microsecond waveform. Provide maximum
48 clamp voltage of 395 V at 20,000 A with a nominal series inductance of 200 μ h. Ensure
49 voltage does not exceed 395 V. Provide devices that comply with Table 1098-3.

TABLE 1098-3	
INSERTION LOSS OF SURGE PROTECTOR	
Frequency (Hz)	Minimum Insertion Loss (dB)
60	0
10,000	30
50,000	55
100,000	50
500,000	50
2,000,000	60
5,000,000	40
10,000,000	20
20,000,000	25

1 Install surge protector in circuit breaker enclosure in a manner that will permit easy
2 servicing. Ground and electrically bond surge protector to cabinet within 2" of surge
3 protector.

4 Furnish and install a suitably sized plastic envelope or container in cabinet for holding
5 cabinet wiring diagrams and equipment manuals. Locate envelope or container so it is
6 convenient for service personnel. Furnish 2 sets of non-fading cabinet wiring diagrams in
7 a paper envelope or container and place them in the plastic envelope or container.

8 **(E) Type F3 Cabinet**

9 Provide 25" high x 22" wide x 15" deep cabinet, dual-circuit flasher, fan, thermostat and
10 switch-controlled cabinet light (15 watt minimum, incandescent).

11 Install a vent or vents at or near the cabinet bottom to permit the intake of air sized for the
12 rated flow of air from the fan, but no smaller than 20 sq. in. Install fan with a minimum
13 100 CFM rating.

14 Equip cabinet with 2 inverse time circuit breakers (20A & 15A) with at least 10,000 RMS
15 symmetrical amperes short circuit current rating installed to ensure personnel servicing
16 the cabinet, including rear of back panel, cannot inadvertently be exposed to a hazard.
17 Install a terminal block that will accommodate service wire as large as number 4 AWG,
18 and connect it to the circuit breaker. Install circuit breakers in addition to any fuses that
19 are a part of the individual control equipment components. Wire switch-controlled
20 cabinet light and thermostatically-controlled fan to the 15A circuit breaker. Provide
21 thermostat with a minimum range of 90° F to 130° F and with a rating sufficient for fan
22 load.

23 Equip cabinet with a duplex receptacle that is connected to the AC out and neutral out
24 terminals of the surge protector.

25 **1098-18 SPREAD SPECTRUM WIRELESS RADIO**

26 **(A) General**

27 Furnish a spread spectrum wireless radio system with all necessary hardware and signage
28 in accordance with the plans and specifications to provide a data link between field
29 devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Provide a radio
30 system with a bi-directional, full duplex communications channel between 2 "line-of-
31 sight" antennas using license free, spread spectrum technology operating in the
32 902 - 928 MHz frequency band.

33 Furnish material conforming to the National Electrical Code (NEC), the National
34 Electrical Safety Code (NESC), Underwriter's Laboratories (UL) or a third-party listing
35 agency accredited by the North Carolina Department of Insurance, and all local safety
36 codes in effect on the date of advertisement. Comply with all regulations and codes
37 imposed by the owner of affected utility poles.

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1 (B) 900 MHz Wireless Radio

2 Furnish license free 902 - 928 MHz radio modem with antennas, coaxial cable and
3 mounting hardware, and configuration software. Design radio modem to work in “point-
4 to-point”, “point-to-multipoint”, “multipoint-to-point” and “multipoint-to-multipoint”
5 configurations. Ensure the spread spectrum wireless radio meets the following minimum
6 requirements:

- 7 (1) License free (ISM) Spread Spectrum radio band (902 - 928 MHz)
- 8 (2) Frequency Hopping Technology (Direct Sequence Spread Spectrum Technology is
9 not acceptable)
- 10 (3) Bi-Directional, Full Duplex
- 11 (4) Provide at least 3 Programmable Radio Frequency (RF) output levels ranging from
12 1mW up to 1 Watt.
- 13 (5) Provide user-selectable radio frequency channels (Min. 50) and hopping patterns
14 (Min. 50) that will allow the user to adjust operating characteristics to avoid
15 interference within the intended 902 - 928 MHz frequency range.
- 16 (6) RS-232 interface capable of operating from 1200 bps to 115.2 Kbps, with 8 or 9 bit
- 17 (7) DB9-F connector for RS-232 port
- 18 (8) Maximum of 8 mSec. end-to-end latency
- 19 (9) 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- 20 (10) Built-in store-and-forward (single radio repeater, back-to-back radio set-ups are not
21 allowed to accomplish this function)
- 22 (11) 32 Bit encryption
- 23 (12) Receiver Sensitivity of -108dBm @ 10^{-6} BER
- 24 (13) Antenna port: Threaded Connector (Nickel and/or Silver Plated Brass)
- 25 (14) Front panel LED indicators (at a minimum):
 - 26 (a) Power
 - 27 (b) Transmit Data
 - 28 (c) Receive Data
 - 29 (d) Data Port Indicators consisting of at least 3 LED's grouped together
30 representing a Low, Medium or High Signal Strength with regards to the
31 communications link with another targeted radio. Software running on a laptop
32 is not acceptable in meeting this requirement for front panel LED Data Port
33 Indicators.
- 34 (15) Operating temperature of -40 to +165°F at 0 to 95% Humidity
- 35 (16) Power supply requirements:
 - 36 (a) Wall Adapter:
 - 37 (i) Input Voltage (120 VAC UL/CSA) wall cube plug-in module
 - 38 (ii) Output Voltage (6VDC to 24VDC)
 - 39 (b) Typical current draw of no greater than 400 mA when powered with 12 VDC
40 input and transmitting one watt of RF output power
 - 41 (c) Radio Sleep mode with a maximum current draw of $<1\mu\text{A}$
- 42 (17) Shelf mounted design

1 Furnish a Radio Frequency Signal Jumper constructed of an RG-58 Coaxial Cable. On
2 one end of the cable supply a RF Threaded Connector that is compatible with the radio
3 supplied and on the other end supply a Standard N-Type Male Connector to mate with
4 the lightning arrestor. Provide the jumper in 6 ft lengths. Ensure that the cable is
5 assembled by a manufacturing facility. Contractor and/or Vendor assembled cables are
6 not acceptable.

7 Furnish an RS-232 data interface cable to be installed between the radio modem and the
8 field device's RS-232 interface. Ensure the cable is compatible with CALTRANS TEES
9 and 2070L compliant controllers. Ensure cable is at least 6 ft long. Ensure that the cable
10 is assembled by a manufacturing facility. Contractor and/or Vendor assembled cables are
11 not acceptable.

12 Ensure that installing the wireless radio system with a fully functional field device
13 (i.e. controller) does not require any field device modifications with regards to hardware
14 or software.

15 **(C) Software**

16 Furnish units with a Windows-based software program that uses a GUI (Graphical User
17 Interface) to provide "remote programming, radio configuration, remote maintenance,
18 diagnostics and spectrum analyzer" features. Ensure the software will operate on all past
19 and current Microsoft® Windows operating platforms: Windows 98®, Windows 2000®,
20 Windows NT®, Windows XP®, Windows Vista® or Windows® 7. Provide
21 configuration software that can be upgraded in the future at no additional charge.

22 Ensure the radio modem is configurable from a single location (i.e. master radio location)
23 via supplied software (no extra cost). Furnish software supplied with drivers to allow
24 easy set-up with all industry standard traffic signal controllers, including 2070 controllers
25 containing custom software written specifically for the North Carolina Department of
26 Transportation. Ensure the supplied software contains pre-written drivers for industry
27 standard radar packages and Dynamic Message Sign controllers.

28 **(D) Directional Antenna (Yagi)**

29 Furnish a directional antenna of welded construction that allows for vertical and
30 horizontal polarization. Furnish an 8.5 dBd Gain or 13 dBd Gain antenna that comply
31 with Table 1098-4.

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TABLE 1098-4 PROPERTIES OF 8.5 dBd GAIN ANTENNA	
Property	Requirement
Frequency Range	896 - 940 MHz
Nominal Gain	8.5 dBd
Front to Back Ratio	18 dB
Horizontal Beamwidth (at half power points)	65 degree
Vertical Beamwidth (at half power points)	55 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Impedance	50 ohms
Length	24"
Rated Wind Velocity	125 mph
Rated Wind Velocity (with 0.5" radial ice)	100 mph
Projected Wind Surface Area (flat plane equivalent)	0.26 sf
Number of Elements	6

TABLE 1098-5 PROPERTIES OF 13 dBd GAIN ANTENNA	
Property	Requirement
Frequency Range	902 - 928 MHz
Nominal Gain	13 dBd
Front to Back Ratio	20 dB
Horizontal Beamwidth (at half power points)	40 degree
Vertical Beamwidth (at half power points)	35 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Impedance	50 ohms
Length	53"
Rated Wind Velocity	125 mph
Rated Wind Velocity (with 0.5" radial ice)	100 mph
Projected Wind Surface Area (flat plane equivalent)	0.46 sf
Number of Elements	13

- 1 Furnish mounting hardware with the antenna that will secure the antenna to a mounting
- 2 pipe that has a 1.1/2" Nominal Pipe Size (approximately 2" OD pipe diameter), as
- 3 recommended by the manufacturer of the antenna and as approved by the Engineer.

(E) Omnidirectional Antenna

Furnish an omnidirectional antenna of a solid, single piece construction in accordance with Table 1098-6.

Property	Requirement
Frequency Range	902 - 928 MHz
Nominal Gain	Typical gains of 3 or 6 dBd (dependent upon gain needed for application)
Termination	Standard N-Type Female Connector
Impedance	50 ohms
VSWR	1.5:1
Vertical Beam Width	33 degrees (3dBd Gain), 17 degrees (6dBd Gain)
Lightning Protection	DC Ground
Power Rating, UHF Frequency	100 Watts
Length	25" (3dBd Gain), 65" (6dBd Gain)
Rated Wind Velocity	125 mph

Furnish mounting hardware with the antenna that will secure the antenna to a mounting pipe that has a 1.5" Nominal Pipe Size (approximately 2" OD pipe diameter), as recommended by the manufacturer of the antenna and as approved by the Engineer.

(F) Antenna Mounting Hardware Kit

Furnish an antenna mounting kit to support the antenna when attached to a metal pole, mast arm or wood pole.

Ensure the Antenna Mounting Hardware Kit includes at least one 96" galvanized steel cable with a stainless steel bolt, nut and lock washer assembly on each end. Ensure the pole base plate accepts a 1 1/2" NPT aluminum pipe, and provides a surface that is at least 6 3/4" long x 4 1/4" to provide contact with the pole. Ensure the pole base plate is designed to allow both ends of the 96" galvanized cables to be secured and tightened to the base plate. Provide a 90 degree elbow with internal threads on both ends to accommodate 1 1/2" NPT aluminum pipes. Provide a 1 1/2" x 18" long aluminum pipe threaded on both ends and a 1 1/2" x 24" aluminum pipe threaded on one end with an end cap.

(G) Coaxial Cable

Furnish 400 Series coaxial cable to provide a link between the antenna and the lightning arrester that meets the following minimum specifications:

Property	Requirement
Attenuation (dB/100 ft) @ 900 MHz	3.9 dB
Power Rating @ 900 Mhz	0.58 kW
Center Conductor	0.108" diameter Copper Clad Aluminum
Dielectric: Cellular PE	0.285" diameter
Shield	Aluminum Tape - 0.291" diameter Tinned Copper Braid - 0.320" diameter
Jacket	Black UV protected polyethylene
Bend Radius	1" with less than 1 ohm impedance change at bend
Impedance	50 ohms
Capacitance	23.9 pF/ft

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1 (H) Standard N-Type Male Connector

2 Furnish Standard N-Type Male Connector(s) of proper sizing to mate with the 400 series
3 coaxial cable and use a crimping method to secure the connector to the coaxial cable.
4 Furnish a connector that meets the following minimum specifications:

- 5 (1) Center Contact: Gold Plated Beryllium Copper (spring loaded, non-solder)
- 6 (2) Outer Contact: Silver Plated Brass
- 7 (3) Body: Silver Plated Brass
- 8 (4) Crimp Sleeve: Silver Plated Copper
- 9 (5) Dielectric: Teflon PTFE
- 10 (6) Water Proofing Sleeve: Adhesive Lined Polyolefin – Heat Shrink
- 11 (7) Attachment Size: Crimp Size 0.429" (minimum) hex
- 12 (8) Electrical Properties:
 - 13 (a) Impedance: 50 ohms
 - 14 (b) Working Voltage: 1000 Vrms (max)
 - 15 (c) Insertion loss: $0.1 \times \sqrt{F_{GHz}}$
 - 16 (d) VSWR: 1.25:1 (max) up to 3GHz

17 (I) Coaxial Cable Shield Grounding and Weatherproofing Kits

18 (1) Furnish a Coaxial Cable Shield Grounding Kit containing components that will
19 adequately bond and ground the cable shield to the pole ground. Ensure the
20 grounding kit complies with MIL-STD-188-124A for coaxial cable and protects the
21 cable from lightning currents of at least 200kA. Ensure each kit is supplied, as
22 a minimum, with the following:

- 23 (a) Preformed Strap: 24 Gauge copper strap that is at least 1 5/8" long and is sized
24 to mate with the 400 series coaxial cable
 - 25 (b) Tensioning Hardware: Copper nuts and lock washers
 - 26 (c) Grounding Lead Cable: #6 AWG, stranded, insulated copper wire
- 27 (2) Furnish a Weatherproofing Kit containing components that will protect the coaxial
28 cable shield grounding system against the ingress of moisture and prevent vibrations
29 from loosening the connections. Ensure the weatherproofing kit is supplied, as
30 a minimum, with the following:
- 31 (a) Butyl Mastic Tape: 3 3/4" wide by 24" long (approximately)
 - 32 (b) Electrical Tape: 2" wide by 20" long (approximately)

33 (J) Lightning Arrestor

34 Furnish a lightning arrestor installed in line between each antenna and its designated
35 radio modem inside the equipment cabinet in accordance with Table 1098-8. Furnish
36 lightning arrestor with multistrike capability, low strike throughput energy, flange mount
37 and bulkhead mount options and a standard N-Type female connector on both the
38 surge-side and protected-side connectors.

**TABLE 1098-8
PROPERTIES OF LIGHTNING ARRESTOR**

Property	Requirement
Filter Type	DC Block (non gas tube design)
Surge	20kA, 800MHz to 2.0GHz \leq 1.1 : 1 VSWR 18kA, 800MHz to 2.3GHz \leq 1.1 : 1 VSWR 18 kA, 700MHz to 2.7GHz \leq 1.2 : 1 VSWR
Insertion Loss	\leq 0.1 dB over frequency range
Max Power	500 W @ 920MHz (750 W at 122° F)
RF Power	300 Watts
Let Through Voltage	\leq ± 3 Volts for 3kA @ 8/20 μ s Waveform
Throughput Energy	\leq 0.5 μ J for 3kA @ 8/20 μ s Waveform
Temperature	-40 to 185° F Storage/Operating
Vibration	1G at 5 Hz up to 100Hz
Unit Impedance	50 Ohm
VSWR	1.1:1
Frequency Range	800 MHz to 2200 MHz

1 **(K) Coaxial cable – Power Divider (Splitter)**

- 2 Furnish a coaxial cable power divider for repeater radio sites in accordance with
3 Table 1098-9. Ensure the power divider accommodates a single primary input RF source
4 and divides/splits the signal (power) equally between 2 output ports.

**TABLE 1098-9
PROPERTIES OF COAXIAL CABLE - POWER DIVIDER**

Property	Requirement
Power Division	2 - Way
Frequency	900 - 1100 MHz
Insertion Loss	0.22 dB
Impedance	50 Ohm
VSWR ref. to 50 Ohm (max)	1.3:1
Max. Input Power	500 Watts
Connectors	Standard N-Type Female
Dimension	2.5"W x 5"L
Weight	1.5 lb (approximately)

5 **(L) Disconnect Switch**

- 6 Furnish a double pole, single throw snap switch in a weatherproof outlet box with cover,
7 suitable for use in wet locations. Ensure outlet box and cover supports a lockout tag
8 device. Ensure outlet box includes one 1/2" diameter hole in back of box. Furnish
9 mounting hardware, sealing gaskets and lockout tag.

10 **(M) Warning Signs and Decal**

- 11 Furnish "RF Warning Sign" and "Decal" at locations called for in the plans. Furnish
12 mounting hardware to secure the sign to either metal or wood poles.

Section 1101

1 (E) Temporary Traffic Control Plan Not Fully Covered in the Contract

2 When the TTC does not cover a particular work function, notify the Engineer to allow for
3 the development or modification of a sealed set of the Temporary Traffic Control Plans.

4 1101-3 BLASTING ZONE

5 When blasting operations are within 1,000 ft of a travelway, provide the appropriate traffic
6 control as shown in the plans and/or the *Roadway Standard Drawings*.

7 1101-4 CONSTRUCTION VEHICLE CROSSINGS

8 Do not cross the median, ramps or loops with vehicles or equipment unless a specific location
9 for crossing is approved and required traffic control devices are used as shown in the
10 *Roadway Standard Drawings*.

11 1101-5 ON-ROAD CONSTRUCTION VEHICLES

12 When operating outside of a closed lane or haul road crossing in a work zone, on-road
13 construction vehicles are subject to the Department's Division of Motor Vehicle weight and
14 safety regulations as commercial vehicles.

15 1101-6 EXCAVATIONS WITHIN TRAVELWAY

16 During the process of excavating in a travelway where traffic is to be later maintained, make
17 provisions to backfill and repair any excavated or damaged pavement before allowing traffic
18 to proceed over the affected lanes. In low speed areas (35 mph or less), metal plates may be
19 used to cover excavated areas.

20 1101-7 HAULING OPERATIONS

21 Comply with the multiple and single vehicle hauling restrictions as shown in the plans when
22 performing hauling of equipment or materials to or from the project.

23 Define "Multiple Vehicle Hauling" as the hauling of equipment or materials to or from the
24 project with delivery at intervals of less than 5 minutes or results in more than one vehicle at
25 a particular work site at a time.

26 Define "Single Vehicle Hauling" as the hauling of equipment or materials to or from the
27 project with delivery at intervals of more than 5 minutes and results in no more than one
28 vehicle at a particular work site at a time.

29 1101-8 MATERIAL AND EQUIPMENT STORAGE AND PARKING

30 When work is not in progress, keep all personnel, equipment, machinery, tools, construction
31 debris and supplies at least 40 ft away from active travel lanes. When vehicles, equipment
32 and materials are protected by concrete barrier or guardrail, they shall be offset at least 5 ft
33 from the barrier or guardrail.

34 1101-9 PARKING OF PERSONAL VEHICLES

35 Provide staging areas for personal vehicle parking a safe distance, at least 40 ft, from open
36 travel lanes except on freeway facilities. Provide staging areas for parking personal vehicles
37 on freeway facilities approved by the Engineer before use.

38 1101-10 PROTECTION OF HAZARDS

39 Mark all hazards with signs, barricades, drums or other warning devices.

40 At each location where work is started which creates a safety hazard, continue the work until
41 completed to the extent that the safety hazard is eliminated. If the work is not pursued in
42 a continuous manner the Engineer will not allow any other work on the project to be
43 performed until the existing safety hazard is eliminated.

1101-11 TEMPORARY LANE CLOSURES**(A) General**

Operate all equipment and personnel within the designated work area during lane closures. Do not impede or stop traffic for the purpose of performing construction related work on the traffic side of the lane closure, except when called for in the Traffic Control Plan.

Install lane closures with the traffic flow, beginning with devices on the upstream side of traffic. Remove lane closures against the traffic flow, beginning with devices on the downstream side of traffic.

Vehicles used to install or remove lane closures shall have flashing or rotating beacons.

(B) Intersections

When construction proceeds through an intersection, provide flaggers and all other necessary traffic control as required by the plans to direct the traffic through the intersection. When an intersection is signalized, ensure authorized personnel place the signal in flash mode before beginning work in the intersection.

1101-12 TEMPORARY ROAD CLOSURES**(A) Traffic Pattern Alternations**

Notify the Engineer 21 calendar days before altering the existing traffic pattern.

Plan all traffic pattern alterations and meet with the Engineer to discuss the implementation strategy before altering traffic. The Engineer will notify the proper authorities and other affected parties as necessary.

(B) Detour

Ensure that all required detour signing and delineation, including work done by others, are in place before placing traffic onto a detour.

(C) Traffic Stoppage

Limit the stoppage of traffic to times specified in the plans. Provide time between consecutive stoppages to allow the traffic queue to deplete.

1101-13 TRAFFIC CONTROL SUPERVISION

Provide the service of at least one qualified work zone supervisor. The work zone supervisor shall have the overall responsibility for the proper implementation of the traffic management plan and ensure all employees working inside the NCDOT right of way have received the proper training appropriate to the job decisions each individual is required to make.

The work zone supervisor is not required to be on site at all times but shall be available to address concerns of the Engineer. The name and contact information of the work zone supervisor shall be provided to the Engineer prior to or at the preconstruction conference.

Qualification of work zone supervisors shall be done by an NCDOT approved training agency or other approved training provider. For a complete listing of these, see the Work Zone Traffic Control's webpage.

Coordinate with and cooperate with traffic control supervisors of adjacent or overlapping construction projects to insure safe and adequate traffic control is maintained throughout the projects at all times including periods of construction inactivity in accordance with Article 105-7.

Section 1105

1 1101-14 VEHICULAR ACCESS

2 Maintain continuous and safe vehicular access, including but not limited to, all residences,
3 businesses, schools, police and fire stations, hydrants, other emergency services, hospitals and
4 mailboxes. Conduct operations so as to limit the inconvenience to property owners.

5 1101-15 PEDESTRIAN ACCESS

6 Maintain pedestrian access at all times as shown in the plans. When existing pedestrian
7 facilities are disrupted, closed or relocated, provide temporary facilities that are detectable and
8 include accessibility features consistent with the features present in the existing pedestrian
9 facility. Avoid pedestrian detours.

10 Determine the extent of pedestrian needs through engineering judgment or by the traffic
11 control supervisor responsible for the work zone. Inspect the work zone regularly so effective
12 pedestrian traffic is maintained.

13 When pedestrian movement through or around a work site is necessary, provide a separate
14 usable footpath. If the previous pedestrian facility was accessible to pedestrians with
15 disabilities, provide a footpath during temporary traffic control that is accessible. Do not have
16 any abrupt changes in grade or terrain that could cause a tripping hazard or could be a barrier
17 to wheelchair use. Provide barriers and channelizing devices that are detectable to pedestrians
18 who have visual disabilities. Provide temporary pedestrian facilities that are made of
19 concrete, asphalt or other suitable material as approved by the Engineer at all locations where
20 the existing sidewalks have been removed for construction operations.

21 Do not sever or move pedestrian facilities for non-construction activities such as parking for
22 vehicles and equipment. Separate pedestrian movements from both work site activity and
23 vehicular traffic.

SECTION 1105

TEMPORARY TRAFFIC CONTROL DEVICES

24 25 26 1105-1 DESCRIPTION

27 Furnish, install, maintain, relocate and remove temporary traffic control devices. All
28 temporary traffic control devices furnished by the Contractor shall remain the property of the
29 Contractor, unless otherwise specified in the contract.

30 1105-2 MATERIALS

31 Refer to Division 10.

32 Use temporary traffic control devices that comply with 23 CFR 630 Subpart K. Provide
33 a Type 7 material certifications in accordance with Article 106-3 at least 72 hours before use
34 for all used temporary traffic control devices.

35 Provide temporary traffic control devices that are listed on the NCDOT Approved Product
36 List.

37 1105-3 CONSTRUCTION METHODS

38 Ensure all temporary traffic control devices are inspected and approved before using them on
39 the project. Install temporary traffic control devices before construction operations begin and
40 during the proper phase of construction. Maintain and relocate temporary traffic control
41 devices during the time they are in use. Keep these devices in place as long as they are
42 needed and immediately remove thereafter. When operations are performed in stages, install
43 only those devices that apply to the present conditions.

1 **1105-4 MAINTENANCE AND INSPECTION**

2 Submit a proposed traffic control device maintenance schedule and checklist for approval
3 before construction. Perform continuous maintenance and daily scheduled inspections of
4 temporary traffic control devices. Review and maintain all traffic handling measures to
5 ensure that adequate provisions are in place for public and workers' safety.

6 Maintenance activities include cleaning, repair or replacement of temporary traffic control
7 devices that are damaged, torn, crushed, discolored, displaced or deteriorated beyond
8 effectiveness.

9 If the name and telephone number of the agency, Contractor or supplier is shown on the
10 non-retroreflective surface of all channelizing devices, use letters and numbers that are
11 non-reflective and not over 2" in height.

12 **1105-5 FAILURE TO MAINTAIN TRAFFIC CONTROL**

13 Failure to maintain acceptable traffic control measures or temporary traffic control devices
14 may result in formal notification of noncompliance. Implement remedial action immediately
15 for imminent danger situations as directed. Implement remedial action within 48 hours after
16 notification of a safety issue that is not an imminent danger. See Articles 107-21 and 108-7.

17 Failure to comply may result in having the work performed with available forces and
18 equipment. In cases of willful disregard for the safety of the public, the Engineer may
19 proceed immediately to implement the measures necessary to provide the appropriate level of
20 traffic control to ensure that the safety of all concerned parties is maintained.

21 **1105-6 MEASUREMENT AND PAYMENT**

22 Payment at the contract unit prices for the various items in the contract will be full
23 compensation for all work covered by this section unless a pay item is included for
24 *Temporary Traffic Control* paid as lump sum.

25 If the Contractor fails to maintain acceptable traffic control measures or temporary traffic
26 control devices and the Engineer implements measures necessary to provide the appropriate
27 level of traffic control, the actual cost of performing said work will be deducted from the
28 monies due the Contractor on the contract.

29 Payment will be made under:

Pay Item	Pay Unit
Temporary Traffic Control	Lump Sum

30 **SECTION 1110**
31 **WORK ZONE SIGNS**

32 **1110-1 DESCRIPTION**

33 Furnish, install, maintain, temporarily cover and uncover, relocate and remove stationary and
34 barricade mounted work zone signs in accordance with the contract.

35 Furnish, install, maintain and relocate portable work zone signs and portable work zone sign
36 stands in accordance with the plans and the *Standard Specifications*. When portable work
37 zone signs and portable work zone sign stands are not in use for periods longer than
38 30 minutes, collapse or remove sign stands and reinstall once work begins again.

Section 1110

1 1110-2 MATERIALS

2 Refer to Division 10.

Item	Section
Barricade Mounted Signs	1089-3
Work Zone Signs	1089-1
Work Zone Sign Supports	1089-2

3 Portable work zone signs shall be roll up or approved composite substrates. Use portable
4 work zone signs only with portable work zone sign stands specifically designed for one
5 another.

6 Provide portable work zone sign stands, portable signs and sheeting that meet NCHRP 350 for
7 Category II temporary traffic control devices and are listed on the NCDOT Approved Product
8 List.

9 Provide portable work zone signs and stands that are crash tested together as a system by the
10 manufacturer. Poor performance of portable work zone signs or portable work zone sign
11 stands at any site, whether or not related to a specific contract, will be grounds for
12 non-acceptance of a product on any project under contract.

13 1110-3 CONSTRUCTION METHODS

14 (A) Work Zone Signs (Stationary)

15 Install work zone signs (stationary) to stand within 2° of plumb in all directions and
16 under all conditions. Erect signs per *Roadway Standard Drawings* No. 1110.01.

17 Splicing of work zone sign (stationary) posts is acceptable. Splice work zone sign
18 (stationary) posts according to *Roadway Standard Drawings* No. 1110.01. Remove
19 entire post when removing signs with spliced posts.

20 When required, cover work zone signs with an opaque material that prevents reading of
21 the sign at night by a driver using high beam headlights. Use material that does not
22 damage the sign sheeting.

23 Any damage incurred from the covering of work zone signs will be determined using
24 Article 901-5. Replace or repair any damaged signs due to the covering.

25 (B) Work Zone Signs (Barricade Mounted)

26 Mount approved composite or roll up signs to barricade rails so the signs do not cover
27 more than 50% of the top 2 rails or 33% of the total area of the 3 rails. Mount signs at
28 least one foot from the ground to the bottom of the sign.

29 (C) Work Zone Signs (Portable)

30 Install the portable work zone sign and sign stand to stand plumb within 10° left and
31 right, within 20° front and back and be capable of standing erect in windy conditions.

32 Install roll up or approved composite signs at least one foot from the bottom of the sign to
33 the edge of pavement elevation on two-lane two-way roadways. Install roll up or
34 approved composite signs at least 5 ft from the bottom of the sign to the edge of
35 pavement elevation on multi-lane roadways.

36 Clean the sign face before use.

37 When not in use for periods longer than 30 minutes, lay the portable work zone sign flat
38 on the ground and collapse the sign stand and lay it flat on the ground.

1 **1110-4 MEASUREMENT AND PAYMENT**

2 Nominal dimensions will be used to compute the sign panel areas.

3 *Work Zone Signs (Stationary)* will be measured and paid as the actual number of square feet
4 satisfactorily installed at each location and accepted by the Engineer. Where a particular sign
5 is used at more than one location, measurement will be made at each location.

6 *Work Zone Signs (Barricade Mounted)* will be measured and paid as the actual number of
7 square feet satisfactorily installed on barricades and accepted by the Engineer. Payment will
8 be made for the initial installation only. Relocation of signs will be incidental to the
9 measurement of the quantity of signs.

10 *Work Zone Signs (Portable)* will be measured and paid as the actual number of square feet
11 satisfactorily installed and accepted by the Engineer. Payment will be made for the initial
12 installation only. Relocation of signs will be incidental to the measurement of the quantity of
13 signs.

14 No direct payment will be made for stationary work zone sign supports or portable work zone
15 sign stands. All stationary work zone sign supports or portable work zone sign stands will be
16 incidental to the work of providing work zone signs.

17 Payment will be made under:

Pay Item	Pay Unit
Work Zones Signs (Stationary)	Square Foot
Work Zones Signs (Barricade Mounted)	Square Foot
Work Zones Signs (Portable)	Square Foot

18 **SECTION 1115**
19 **FLASHING ARROW BOARDS**

20 **1115-1 DESCRIPTION**

21 Furnish, install, place, operate, maintain, relocate and remove arrow boards.

22 **1115-2 MATERIALS**

23 Refer to Division 10.

Item	Section
Flashing Arrow Boards	1089-6

24 Use arrow boards that are on the NCDOT Approved Product List.

25 Poor performance of arrow boards at any site, whether or not related to a specific contract,
26 will be grounds for non-acceptance of a product on any project under contract.

27 **1115-3 CONSTRUCTION METHODS**

28 Use arrow boards that have the capability to display mode selections.

29 Do not use straight-line caution or chevron displays.

30 Mount flashing arrow boards on trucks, trailers or other mobile units.

31 Expedite repairs due to failure, malfunction or damage to an arrow board. Furnish another
32 arrow board approved by the Engineer during the repair time. Repair or replace arrow boards
33 immediately; otherwise, suspend all construction activities requiring the use of the sign until
34 the sign is restored to operation.

35 Perform all maintenance operations recommended by the manufacturer of the sign.

Section 1120

1 **1115-4 MEASUREMENT AND PAYMENT**

2 *Flashing Arrow Board* will be measured and paid as the maximum number of boards
3 satisfactorily placed and accepted by the Engineer in use at any one time during the life of the
4 project as required by the contract.

5 Replacement, repair and maintenance of arrow boards will be incidental to the work of this
6 section.

7 Payment will be made under:

Pay Item	Pay Unit
Flashing Arrow Board	Each

8 **SECTION 1120**
9 **PORTABLE CHANGEABLE MESSAGE SIGNS**

10 **1120-1 DESCRIPTION**

11 Furnish, install, maintain, relocate and remove portable changeable message signs.

12 **1120-2 MATERIALS**

13 Refer to Division 10.

Item	Section
Portable Changeable Message Signs	1089-7

14 Use portable changeable message signs that are on the NCDOT Approved Product List.

15 Poor performance of portable changeable message signs at any site, whether or not related to
16 a specific contract, may be grounds for non-acceptance of a product on any project under
17 contract.

18 **1120-3 CONSTRUCTION METHODS**

19 Mount all portable changeable message signs on a trailer or truck so as to support the message
20 board in a level position and in accordance with the plans. Align and sight the portable
21 changeable message sign to provide optimal driver visibility. Messages on a portable
22 changeable message sign shall consist of no more than 2 phases, and a phase shall consist of
23 no more than 3 lines of text. Each phase shall be capable of being understood by itself,
24 regardless of the order in which it is read. Messages shall be centered and uppercase within
25 each line of the legend. If more than one portable changeable message sign is simultaneously
26 legible to road users, then only one of the signs shall display a sequential message at any
27 given time. As guidance, the display time for each phase shall be at least 2 seconds, and
28 the sum of the display times for both of the phases shall be no more than 8 seconds. Sign
29 operator will adjust the display rate so the 2 phase message can be understood by the motorist
30 approaching the sign at the posted speed limit. Relocate the units for the various stages of
31 construction as shown in the plans or as needed to inform the motorists.

32 Provide an experienced operator for the portable changeable message sign during periods of
33 operation to ensure that the messages displayed on the sign panel are in accordance with the
34 plans and in accordance with message content guidelines. Ensure that the message sign is
35 illuminated properly to meet the existing light conditions, and that all adjustments for
36 operation of the sign are made as needed to properly guide motorists.

37 Expedite repairs due to failure, malfunction or damage to a portable changeable message sign.
38 Furnish another changeable message sign during the repair time. Repair or replace portable
39 changeable message sign immediately; otherwise, suspend all construction activities requiring
40 the use of the sign until the sign is restored to operation.

1 Perform all maintenance operations recommended by the manufacturer of the sign. Include
2 the periodic cleaning of the sign face and associated solar panels in maintenance operations.

3 **1120-4 MEASUREMENT AND PAYMENT**

4 *Portable Changeable Message Signs* will be measured and paid as the maximum number of
5 portable changeable message signs acceptably placed and in operation, at any one time during
6 the life of the project. Payment for *Portable Changeable Message Signs* will be made on the
7 following schedule:

- 8 (A) 70% of the unit bid upon placing the unit in service,
9 (B) 20% of the unit bid when the project is 50% complete, and
10 (C) 10% of the unit bid when the project is 100% complete.

11 *Portable Changeable Message Signs (Short Term)* will be measured and paid as the actual
12 number of days the portable changeable message sign (short term) is used on a project for
13 a specific work operation, removed from the project after the specific operation is complete
14 and remains in use on the project no longer than 30 days.

15 Replacement, repair and maintenance of changeable message signs will be incidental to the
16 work of this section.

17 Payment will be made under:

Pay Item	Pay Unit
Portable Changeable Message Sign	Each
Portable Changeable Message Sign (Short Term)	Day

18 **SECTION 1130** 19 **DRUMS**

20 **1130-1 DESCRIPTION**

21 Furnish, install, maintain, relocate and remove drums with ballast.

22 **1130-2 MATERIALS**

23 Refer to Division 10.

Item	Section
Drums	1089-5

24 Provide drums that are on the NCDOT Approved Product List.

25 **1130-3 CONSTRUCTION METHODS**

26 Use the same type of reflective sheeting on all drums installed at any one time during the life
27 of the project. Spacing of these devices is equal in feet to the speed limit in the taper and
28 twice the speed limit in the tangent sections.

29 Use a ballasting method in accordance with manufacturer's specification. When using a tire
30 ballasting method, use approved manufacturer's tires and place the tires flush with the ground.

31 Immediately replace any drum, ballast or reflective sheeting that are torn, crushed, discolored
32 or otherwise damaged.

33 **1130-4 MEASUREMENT AND PAYMENT**

34 *Drums* will be measured and paid as the maximum number of drums acceptably placed and in
35 use at any one time during the life of the project.

36 Relocation, replacement or repair of drums, ballasts or reflective sheeting will be incidental to
37 the work of this section.

Section 1135

1 Payment will be made under:

Pay Item	Pay Unit
Drums	Each

2 **SECTION 1135**
3 **CONES**

4 **1135-1 DESCRIPTION**

5 Furnish, install, relocate, maintain and remove cones and reflective cone collars.

6 **1135-2 MATERIALS**

7 Refer to Division 10.

Item	Section
Cones	1089-4

8 Provide cones that are on the NCDOT Approved Product List.

9 **1135-3 CONSTRUCTION METHODS**

10 Use reflective adhesive sheeting on all cones used between dusk and dawn. Use the same
11 type of reflective sheeting on all cone collars installed at any one time during the life of the
12 project. Do not use cones in the upstream taper of lane or shoulder closures for multilane
13 roadways. Do not use cones for longer than 3 consecutive days.

14 Use ballasting methods in accordance with manufacturer's specification.

15 Cones may be used on all facilities for daytime and nighttime work with speed limits at or
16 below 55 mph. If used at night, the cones shall have adhesive reflective sheeting and shall
17 meet the height requirements in the *Roadway Standard Drawings*.

18 Cones may be used instead of drums, where allowed in the TTC plans or by the Engineer, on
19 facilities with speed limits above 55 mph, if both the work is performed during daylight
20 conditions and the devices are removed after each work period. Drums shall be used in the
21 tapers.

22 The maximum spacing for cones on multi-lane roadways is equal in feet to the posted speed
23 limit.

24 Immediately replace any cone that is torn, crushed, discolored or otherwise damaged.

25 **1135-4 MEASUREMENT AND PAYMENT**

26 *Cones* will be measured and paid as the maximum number of cones acceptably placed and in
27 use at any one time during the life of the project.

28 Relocation, replacement, repair and maintenance of cones will be incidental to the work of
29 this section.

30 Payment will be made under:

Pay Item	Pay Unit
Cones	Each

31 **SECTION 1145**
32 **BARRICADES**

33 **1145-1 DESCRIPTION**

34 Furnish, erect, maintain, relocate, ballast and remove barricades.

1 **1145-2 MATERIALS**

2 Refer to Division 10.

Item

Barricades

Section

1089-3

3 Provide barricades that meet NCHRP 350 for Category II traffic control devices and are on
4 the NCDOT Approved Product List.5 **1145-3 CONSTRUCTION METHODS**6 At the end of the workday, properly close the road where construction equipment accesses
7 a road closure through Type III barricades.8 Use sandbags or other approved ballasting methods to prevent overturning of barricades by
9 the wind. If needed, place sandbags or other acceptable ballasting on the feet of the frame.
10 Do not ballast barricades with objects such as rocks or chunks of concrete.11 Do not anchor barricades to any pavement surfaces unless such anchoring method has passed
12 the crash test requirement of NCHRP 350 for work zone category II devices.

13 Point the striped diagonals on the barricade rails in the direction of traffic flow.

14 **1145-4 MAINTENANCE**15 Periodically inspect barricades and ballast. Replace any ballast as needed, including sandbags
16 that have loose sand outside the bag.17 **1145-5 MEASUREMENT AND PAYMENT**18 *Barricades (Type III)* will be measured and paid as the maximum number of linear feet of
19 barricades acceptably placed and in use at any one time during the life of the project.
20 Measurement will be made of the total length of each barricade along one rail.21 Relocation, replacement, repair and maintenance of barricade will be incidental to the work of
22 this section.

23 Payment will be made under:

Pay Item

Barricades (Type III)

Pay Unit

Linear Foot

24

SECTION 1150

25

FLAGGERS26 **1150-1 DESCRIPTION**27 Furnish, relocate and maintain the flaggers, hats, vests, STOP/SLOW paddles and any other
28 incidentals necessary to control traffic.29 **1150-2 MATERIALS**

30 Refer to Division 10.

Item

Flaggers

Section

1089-10

31 Refer to *Roadway Standard Drawings* No. 1150.01.

Section 1160

1 **1150-3 CONSTRUCTION METHODS**

2 Provide the service of properly equipped and qualified flaggers (see *Roadway Standard*
3 *Drawings* No. 1150.01) at locations and times for such period as necessary for the control and
4 protection of vehicular and pedestrian traffic. Anyone who controls traffic is required to be
5 qualified. Qualification consists of each flagger receiving proper training in the set-up and
6 techniques of safely and competently performing a flagging operation. Qualification of
7 flaggers is to be done by an NCDOT approved training agency or other approved training
8 provider. For a complete listing of these, see the Work Zone Traffic Control’s webpage.

9 Prior to beginning work on the project, a Qualification Statement that all flaggers used on the
10 project have been properly trained through an NCDOT approved training resource shall be
11 provided to the Engineer.

12 Use flagging methods that comply with the guidelines in the MUTCD.

13 **1150-4 MEASUREMENT AND PAYMENT**

14 Flagging conducted for the convenience of the Contractor’s operations is not compensated.
15 The Department will pay for flaggers, including those used at Y-lines that are used in
16 conjunction with a lane closure. Flaggers used for operations not involving a lane closure will
17 be incidental to that operation and no payment will be made. Flaggers used for hauling
18 operations, where the only need for a lane closure is due to the hauling operation, will be
19 incidental to that operation and no payment will be made.

20 Any flagger used for less than one hour will be incidental to that operation.

21 *Flagger (Day)* will be measured and paid as the actual number of days that each flagger is
22 satisfactorily provided and accepted by the Engineer during the life of the project. On any
23 calendar day that more than one flagger is used, the quantity to be paid on that calendar day
24 will be the maximum number of flaggers used at one time in that calendar day.

25 *Flagger (Hour)* will be measured and paid as the actual number of hours that each flagger is
26 satisfactorily provided and accepted by the Engineer during the life of the project.

27 Payment will be made under:

Pay Item	Pay Unit
Flagger	Day
Flagger	Hour

28 **SECTION 1160**
29 **TEMPORARY CRASH CUSHIONS**

30 **1160-1 DESCRIPTION**

31 Furnish, install, maintain, reset and remove temporary crash cushions.

32 **1160-2 MATERIALS**

33 Refer to Division 10.

Item	Section
Temporary Crash Cushions	1089-8

34 Use temporary crash cushions that meet NCHRP 350 Test Level II or III for transportation
35 management devices and are on the NCDOT Approved Product List.

36 Historical performance of the temporary crash cushions will help determine the future use of
37 the material by the Department. Poor performance of temporary crash cushions at any site,
38 whether or not related to a specific contract, may be grounds for non-acceptance of a product
39 on any project under contract.

1 **1160-3 CONSTRUCTION METHODS**

2 Before use, furnish the Engineer detailed brochures, specifications and other manufacturer's
3 data that completely describe the performance criteria, installation and instructions for the
4 crash cushion. Ensure that the crash cushion is rated for at least the same speed as the facility
5 on which it will be used.

6 The Contractor may provide a portable base for installation. When a portable base is used,
7 provide one that is designed or approved by the manufacturer of the temporary crash cushion.

8 Install temporary crash cushions in accordance with the manufacturer's specifications.

9 Use temporary crash cushions that have a yellow reflective end treatment to delineate the
10 approach end of the crash cushion to oncoming traffic.

11 Repair any pavement damaged by the installation or removal of a temporary crash cushion.

12 Repair or replace within 24 hours any temporary crash cushion that becomes crushed or
13 otherwise damaged to the point that it will not perform its intended purpose. Suspend all
14 construction activities until the temporary crash cushion is repaired or replaced. Provide safe
15 control of traffic until the temporary crash cushion has been repaired or replaced using
16 approved methods.

17 **1160-4 MEASUREMENT AND PAYMENT**

18 *Temporary Crash Cushions* will be measured and paid as the actual number of crash cushions
19 furnished, satisfactorily installed and accepted by the Engineer.

20 *Reset Temporary Crash Cushions* will be measured and paid as the actual number of crash
21 cushion relocations as directed.

22 Repair or replace damaged temporary crash cushions at no cost to the Department. Repair or
23 replace damaged pavement at no cost to the Department.

24 Payment will be made under:

Pay Item	Pay Unit
Temporary Crash Cushion	Each
Reset Temporary Crash Cushion	Each

25

SECTION 1165

26

TRUCK MOUNTED ATTENUATORS

27 **1165-1 DESCRIPTION**

28 Furnish, install, operate, maintain and relocate truck mounted attenuators (TMA).

29 **1165-2 MATERIALS**

30 Refer to Division 10.

Item	Section
Truck Mounted Attenuators	1089-9

31 Use TMAs that meet NCHRP 350 Test Level II or III for transportation management devices
32 and are on the NCDOT Approved Product List.

33 Historical performance of the TMA will help determine the future use of the material by the
34 Department, even if the TMA has been approved. Poor performance of TMA at any site,
35 whether or not related to a specific contract, may be grounds for non-acceptance of a product
36 on any project under contract.

Section 1170

1 **1165-3 CONSTRUCTION METHODS**

2 Before use, furnish the Engineer detailed brochures, specifications and other manufacturer’s
3 data that completely describes the performance criteria, installation and instructions for the
4 TMA.

5 Use only TMAs that meet the crash test requirements of Subarticle 1089-9(A).

6 Do not park TMAs against rigid objects (i.e. bridge piers or portable concrete barrier) except
7 as a temporary safety measure and in no case for longer than 72 hours. Install the TMA on
8 a truck that is fully operational, in good running order and in accordance with the
9 manufacturer’s specifications.

10 Use the appropriate lighting and delineation on the truck and TMAs as shown in the contract.

11 Repair or replace within 24 hours any attenuator that becomes crushed or otherwise damaged
12 so that it will perform its intended purpose. Suspend all construction activities until the
13 attenuator is repaired or replaced. Provide safe control of traffic until the attenuator has been
14 repaired by using approved methods.

15 **1165-3 MEASUREMENT AND PAYMENT**

16 TMA will be measured and paid as the maximum number of TMAs acceptably placed and in
17 use at any one time during the life of the project for all operations other than Moving and
18 Mobile Operations. TMAs will be incidental to all moving and mobile operations. In the
19 case of emergency situations, TMAs will not be paid when payment has already been made
20 for a stationary unit.

21 Relocation of TMAs will be incidental to the measurement of the quantities of TMAs and no
22 separate payment will be made.

23 Payment will be made under:

Pay Item	Pay Unit
TMA	Each

24 **SECTION 1170**
25 **POSITIVE PROTECTION**

26 **1170-1 DESCRIPTION**

27 Furnish, install, secure, maintain, remove and reset portable concrete barrier or water filled
28 barrier.

29 **1170-2 MATERIALS**

30 Refer to Division 10.

Item	Section
Anchor Bolts	1072-4
Anchor Bolt Adhesive	1081
Freeze-Thaw Durable Grout, Nonshrink	1003
Guardrail and Barrier Delineators	1088-2
Portable Concrete Barrier	1077

31 Provide grout with a compressive strength at 3 days of at least 5,000 psi for portable concrete
32 barriers.

33 Provide portable concrete barrier that meets NCHRP 350 Test Level III. Alternatively,
34 provide water filled barrier that meets NCHRP 350 Test Level II for work zones that have
35 a posted speed limit of 45 mph or less. Use barrier on the NCDOT Approved Product List.

1 Provide water-filled barrier that acts as its own free standing, non-redirective end treatment.
2 If water-filled barrier is provided, use environmentally safe anti-freezing agent in the water
3 per manufacturer specifications and recover agent when the barrier is drained. Dispose of
4 water and agent properly. Do not drain water filled barrier into or across an existing travel
5 lane. Provide barrier units that are capable of being lifted and moved when filled, if draining
6 is not possible.

7 Use any of the several alternate delineator types for barrier (see *Roadway Standard Drawings*)
8 that are on the NCDOT Approved Product List.

9 Historical performance of the barrier will help determine future use of the material by the
10 Department, even if the barrier has been approved. Poor performance of the barrier at any
11 site, whether or not related to a specific contract, may be grounds for non-acceptance of
12 a product on any project under contract.

13 **1170-3 CONSTRUCTION METHODS**

14 **(A) General**

15 Place all types of portable concrete barrier or water filled barrier as shown in the contract.
16 When required by the plans, anchor barrier by an approved method as shown in the
17 *Roadway Standard Drawings*.

18 Use one type of barrier on any continuous run of barrier within the project.

19 Use portable concrete barrier that avoids trapping water in sags, vertical curves, areas of
20 wedging and paving where super-elevations have been changed and other low spots as
21 directed. Provide adequate drainage behind the portable concrete barrier.

22 Lift, place and reset portable concrete barrier units using a two-point pick up, or other
23 acceptable method, which does not over-stress, damage or mar the surface of the
24 roadway. Do not use connection points for lifting purposes.

25 Do not use any barrier units that are cracked, damaged, chipped or otherwise
26 nonfunctional.

27 Place and install water filled barrier units as shown in the plans and per manufacturer
28 specifications on roadways with posted speed limits of 45 mph or less.

29 Furnish delineators for barrier.

30 **(B) Securing Barrier On Concrete and Asphalt Pavement Surfaces**

31 Use anchoring methods shown in *Roadway Standard Drawings*.

32 (1) Anchoring Method for Asphalt Pavements

33 Drill anchor holes normal to the surface of installation using a pneumatic drill with
34 a depth indicator, unless another drilling method is allowed. Make sure that the
35 diameter of the hole is in strict conformance with the *Roadway Standard Drawing*
36 No. 1170.01 or the manufacturer's recommendations. When directed, use a jig or
37 fixture to ensure correct positioning of the holes and proper alignment during the
38 drilling process. Adjust hole locations, as necessary, to avoid encountering
39 reinforcing steel. Immediately after drilling, brush the holes with a stiff-bristled
40 brush of a sufficient size to effectively remove dust from the sides of the hole, and
41 blow all holes free of all dust and debris using oil free compressed air. Repeat this
42 procedure until the hole is completely clean.

43 Inspect each hole immediately before placement of the anchor. Rework any hole
44 found to deviate from these requirements to ensure that an acceptable hole is
45 achieved.

Section 1170

1 Check each hole with a depth gauge to ensure proper embedment depth, if required.

2 Satisfactorily repair all spalled or damaged pavement.

3 Once the barrier and anchors are removed, fill the holes with grout. These
4 requirements may be waived if the bridge or roadway will no longer be used by
5 traffic.

6 (2) Adhesive Anchoring Method for Concrete Surfaces

7 Comply with Subarticle 1170-3(B)(1).

8 Mix adhesives in strict conformance with the manufacturer's instructions.

9 Pour the mixed adhesive into the hole. Agitate or rotate anchors to ensure complete
10 wetting and encapsulation. Insert the anchors to the specified depth. Completely fill
11 the anchor hole with adhesive and remove any excess adhesive flush with the
12 pavement. Do not disturb any anchors while the adhesive is hardening.

13 Coat all anchors to be adhesively bonded with a debonding agent to ease removal.
14 Formulate the debonding agent such that it does not reduce the strength of the anchor
15 system.

16 (3) Through the Deck Anchoring Method

17 Comply with Subarticle 1170-3(B)(1).

18 Anchor barrier to bridge decks as shown in *Roadway Standard Drawings*
19 No. 1170.01, Sheet 4. Do not use this method on prestressed concrete bridge deck
20 panels.

21 (C) **Resetting Barrier**

22 Reset portable concrete barrier as shown in the plans.

23 (D) **Stockpiling**

24 Stockpile the portable concrete barrier when the barrier is not used on the project or it
25 becomes necessary to stockpile units between 2 separate installations. Stockpile the
26 barrier at a location off the project of your choosing, unless otherwise noted in the plans,
27 or to a location within the project limits, if provided.

28 (E) **Barrier Delineators**

29 Use only one delineator type for barrier throughout the project.

30 The delineators consist of a reflector and base or casing. Attach the delineator to the
31 barrier as shown in the *Roadway Standard Drawings*. Use one attachment position
32 throughout the project length.

33 Position delineators perpendicular to the centerline of the road. Use yellow delineators in
34 the median and on the left side of one-way ramps, loops or other one-way facilities. Use
35 crystal delineators on the right side of divided highways, ramps, loops and all other one-
36 way or two-way facilities. In all cases, the color of the delineator shall supplement the
37 color of the adjacent edgelines.

38 **1170-4 MEASUREMENT AND PAYMENT**

39 *Portable Concrete Barrier* (____) will be measured and paid as the actual number of linear
40 feet furnished, satisfactorily installed, accepted by the Engineer, maintained and removed.
41 Measurement will be made by counting the number of barrier units used and multiplying by
42 the length of a unit.

1 *Water Filled Barrier* will be measured and paid as the actual number of linear feet furnished,
 2 satisfactorily installed, accepted by the Engineer, maintained and removed. Measurement will
 3 be made by counting the number of barrier units used and multiplying by the length of a unit.

4 *Reset Portable Concrete Barrier* (____) will be measured and paid as the number of linear
 5 feet of barrier moved from one location on the project to another location on the project.
 6 Measurement will be made by counting the number of barrier units moved during any one
 7 move and multiplying by the length of a unit. Where barrier units are moved more than once,
 8 each move will be measured separately. Whenever the Engineer directs the Contractor to
 9 move barrier units from an installed location to a stockpile either on or off the project and
 10 then back to another installed location, the complete move from the first installed location to
 11 the next installed location will be measured as 2 moves.

12 *Resetting Water Filled Barrier* will be measured and paid as the actual number of linear feet
 13 furnished, satisfactorily installed, accepted by the Engineer, maintained and removed.
 14 Measurement will be made by counting the number of barrier units used and multiplying by
 15 the length of a unit.

16 Provide barrier stockpile areas at no cost to the Department. Barrier delineators will be
 17 incidental to these pay items.

18 Payment will be made under:

Pay Item	Pay Unit
Portable Concrete Barrier	Linear Foot
Portable Concrete Barrier (Anchored)	Linear Foot
Water Filled Barrier	Linear Foot
Reset Portable Concrete Barrier	Linear Foot
Reset Portable Concrete Barrier (Anchored)	Linear Foot
Reset Water Filled Barrier	Linear Foot

19 **SECTION 1180**
 20 **SKINNY DRUMS**

21 **1180-1 DESCRIPTION**

22 Furnish, install, maintain, relocate and remove skinny drums with ballast.

23 **1180-2 MATERIALS.**

24 Refer to Division 10.

Item	Section
Skinny Drums	1089-5

25 Provide skinny drums that are on the NCDOT Approved Product List.

26 **1180-3 CONSTRUCTION METHODS**

27 Use the same type of reflective sheeting (Type III High Intensity Prismatic or greater) on all
 28 skinny drums installed at any one time during the life of the project. Use ballasting methods
 29 in accordance with manufacturer's specification.

30 Immediately replace any skinny drum, ballast or reflective sheeting that are torn, crushed,
 31 discolored or otherwise damaged.

32 Skinny drums may be used instead of cones on all facilities with speed limits of 55 mph and
 33 below. Spacing of these devices is equal in feet to the speed limit in the taper and twice the
 34 speed limit or every other skip in the tangent sections.

Section 1180

- 1 Skinny drums may be used instead of cones and drums where allowed in the TTC plans or by
- 2 the Engineer on facilities with speed limits above 55 mph, if all the following apply:
- 3 (A) The work is performed during daylight conditions,
- 4 (B) The devices are removed after each work period and
- 5 (C) Drums are used in the tapers.
- 6 Do not use skinny drums on control-of-access facilities with speed limits above 55 mph that
- 7 either involve night work or allow devices to remain in place overnight.
- 8 Do not use skinny drums for tapers on multilane or control-of-access roadways with speed
- 9 limits above 55 mph.
- 10 Do not intermix with drums or cones unless directed by the Engineer or the TTC.

11 **1180-4 MEASUREMENT AND PAYMENT**

- 12 *Skinny Drums* will be measured and paid as the actual number of skinny drums satisfactorily
- 13 placed, accepted by the Engineer and in use at any one time during the life of the project.
- 14 Relocation, replacement, repair and maintenance of skinny drums will be incidental to the
- 15 work of this section.
- 16 Payment will be made under:

Pay Item	Pay Unit
Skinny Drum	Each

DIVISION 12

PAVEMENT MARKINGS, MARKERS AND DELINEATION

SECTION 1205

PAVEMENT MARKING GENERAL REQUIREMENTS

1205-1 DESCRIPTION

Furnish, install and remove pavement markings in accordance with the contract.

1205-2 MATERIALS

(A) General

Refer to Division 10.

Item	Section
Pavement Markings	1087

(B) Material Qualifications

Use pavement markings that are on the NCDOT Approved Products List.

(C) Performance

Poor performance of pavement marking materials at any site, whether or not related to a specific contract may be grounds for nonacceptance of a product on any project under contract.

1205-3 CONSTRUCTION METHODS

Do not use handliners or any other non-truck mounted pavement marking machine to install pavement markings for long line applications of any one line longer than 1,000 ft.

(A) Testing Procedures

All pavement marking materials and placement will be tested by the Department. Install pavement markings in order to meet the retroreflectivity requirements as measured by a Department approved 30 m mobile or handheld retroreflectometer.

(B) Application Equipment

(1) General for all Application Equipment

Use pavement marking application equipment such that all parts that come in contact with pavement marking material are constructed for easy accessibility during cleaning and maintenance.

Keep the marking guns of the application device in full view of the operators at all times. Use applicators that are mobile and maneuverable to the extent that straight lines can be followed and all standard curves can be made in true arcs.

(2) Glass Bead/Element Dispensing Equipment

Apply drop-on beads/elements to the surface of pavement long line markings using an automatic high pressurized bead dispenser or a pressurized mechanical feed, attached to the marking equipment. Hand liner type equipment is exempt from this requirement. Locate the bead/element applicator at the proper distance behind the application of pavement marking material to provide the proper amount of retroreflectivity. Equip the bead applicator with an automatic cut-off control synchronized with the cut-off control of the marking material.

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- 1 Spread the beads/elements uniformly over the entire surface of the pavement
2 marking material such that they are partially embedded in the pavement marking.
3 A 60% bead embedment depth provides optimum retroreflectivity.

4 (C) Weather Limitations and Seasonal Limitations for All Markings

- 5 Do not place pavement markings when moisture tests conducted on the pavement show
6 signs of moisture presence on the pavement or when it is anticipated that damage caused
7 by moisture may occur during the installation and drying periods.

8 (D) Time Limitations for Replacement

TABLE 1205-1 TIME LIMITATIONS FOR REPLACEMENT		
Facility Type	Marking Type	Replacement Deadline
Full-control-of-access multi-lane roadway (4 or more total lanes) and ramps, including Interstates	All markings	By the end of each workday's operation if the lane is opened to traffic
Multi-lane roadways (3 or more lanes) and ramps	Center Line, Lane Line, Railroad symbols, Stop bars, and school symbols	By the end of each workday's operation if the lane is opened to traffic (temporary paint with beads may be used)
	Edge Lines, gore lines and all other symbols	By the end of the 3rd calendar day after obliteration
Two-lane, two-way roadways	All centerline markings, railroad, Stop bars and school symbols	By the end of the 5th calendar day after obliteration
	Edge Lines and all other symbols	By the end of the 15th calendar day after obliteration

- 9 A multilane facility is defined as any roadway having more than two lanes to include
10 a two-lane / two-way roadway with a center two-way left turn lane.

11 (E) Premarking/Interim/Temporary Markings

- 12 Premarking (or layout markings) are small paint spots used by striping contractors to
13 establish locations of pavement markings. Premark each installation of the final
14 pavement marking materials before application on new pavement and when required to
15 replace existing pavement marking, except when existing markings are visible. Get the
16 premarking inspected and approved by the Engineer before placing the pavement
17 marking materials.

- 18 Interim paint is a thin layer of pavement marking paint applied at the striping contractor's
19 option to maintain traffic, instead of durable pavement markings. Apply interim paint to
20 comply with time limitations for placement if final pavement markings cannot be placed.
21 Interim markings shall be no more than 1/4" less than the specified line width of the
22 existing markings.

- 23 Place temporary paint markings for detours, lane shifts, milled surfaces and lifts of
24 asphalt other than the final pavement surface.

- 25 Review and record the existing pavement markings before resurfacing and reestablish the
26 new pavement markings using the record of existing markings in conjunction with the
27 *Roadway Standard Drawings*, unless otherwise directed. Submit the record of the
28 existing pavement markings 7 calendar days before the obliteration of any pavement
29 markings.

(F) Surface Preparation and Curing Compound Removal

Prepare the pavement to accept pavement markings to insure maximum possible adhesion. Clean, seal and remove curing compound as necessary to insure that the markings adhere to the pavement. Obtain approval for all surface preparation methods before implementing.

Pavements shall be free of grease, oil, mud, dust, dirt, grass, loose gravel and other deleterious material, before applying pavement markings.

Prepare the pavement surface, including removal of curing compound, at least 2" wider than the pavement markings to be placed, such that, an additional 1" of prepared area is on all sides of the pavement markings after they are applied.

Remove all curing compound and surface laitance on Portland cement concrete pavements where long-life pavement markings will be placed. Perform curing compound removal by high-pressure water blasting or grinding methods. Ensure that the surface is free of all residue, laitance and debris before applying the pavement marking. When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air immediately before installing the pavement markings.

If required, apply a primer sealer to pavement surfaces before applying pavement marking material as recommended by the manufacturer. Apply primer sealer in a continuous film at least 2" wider than the pavement markings in such a way as not to cause any noticeable change in the appearance of the pavement markings.

Conduct all pavement surface preparation including curing compound removal in such a manner that the pavement or joint material is not damaged or left in a condition that will mislead or misdirect the motorist. Repair any damage caused to the pavement, or joint materials caused by surface preparation or the removal of curing compound by acceptable methods and at no additional cost to the Department.

Where pavement surface preparation results in obscuring existing pavement markings of a lane occupied by traffic, immediately remove the residue, including dust, by approved methods.

(G) Application of Pavement Markings**(1) General for all types of Pavement Markings**

Install pavement marking material that has a uniform thickness, smooth surfaced cross section throughout its entire length, width and length not less than the dimensions specified in the plans and that does not exceed the dimension by more than 1/2".

Do not apply pavement marking materials over a longitudinal joint. See *Roadway Standard Drawings* No. 1205.01, Sheet 2 of 2 for details.

Install pavement marking lines that are straight or have uniform curvature and conform to the tangents, curves and transitions as specified in the plans.

Produce finished lines that have well defined edges and are free of horizontal fluctuations. Do not exceed 1/2" in lateral deviation from the proposed location alignment at any point. Any greater deviations may be cause for requiring the material to be removed and replaced at no additional cost.

Apply all longitudinal pavement marking lines 8" or less in width with one pass of the pavement marking equipment. Pavement marking lines greater than 8" in width and pavement marking symbols may be applied with multiple passes of the pavement marking equipment.

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1 Install all pavement marking lines, stop bars, characters and symbols that require
2 multiple passes of the application equipment such that there are no gaps separating
3 the application passes.

4 Install characters and symbols so that they conform to the sizes and shapes shown in
5 the plans.

6 Protect the pavement markings until they are track free. Repair any markings
7 tracked by a vehicle by acceptable methods.

8 Remove all pavement marking materials spilled on the road surface by acceptable
9 methods.

10 Use yellow, white and black pavement markings, without drop-on glass beads, that
11 visually match the color chips that correspond to the Federal Test Standard No. 595a
12 for the following colors. Use markings that when subjected to accelerated
13 weathering as described in U.S. Federal Specification No. TT-P-115F are within the
14 tolerance limits of the color chips listed below:

White: Color No. 17886

Yellow: Color No. 13538

Black: Color No. 37038

15 (2) Glass Bead/Element Application

16 "Drop-on" is the method where glass beads are dispensed by a pressurized
17 mechanical feed or high pressure means onto the pavement marking as it is applied
18 to the pavement. Drop-on bead dispensing for symbols stop bars and characters may
19 be accomplished by gravitational methods.

20 **(H) Observation Period**

21 Maintain responsibility for debonding and color of the pavement markings during
22 a 12 month observation period beginning upon final acceptance of the project as defined
23 under Article 105-17. Guarantee the markings under the payment and performance bond
24 in accordance with Article 105-17.

25 During the 12 month observation period, provide pavement marking material that shows
26 no signs of failure due to blistering, chipping, bleeding, discoloration, smearing or
27 spreading under heat or poor adhesion to the pavement materials. Pavement markings
28 that bonded during application and were approved, but debond due to snowplowing will
29 not be considered a failed marking. Replace, at no additional expense to the Department,
30 any pavement markings that do not perform satisfactorily under traffic during the
31 12 month observation period.

32 **(I) Removal of Pavement Markings**

33 This work includes the removal of all types of pavement marking lines, symbols and
34 characters including removal for long life marking preparation. This work does not
35 include removal of removable tape pavement markings.

36 Remove pavement marking lines, characters and symbols by acceptable methods to the
37 Engineer that will not materially or structurally damage the surface or the texture of the
38 pavement. Leave the pavement surface in a condition that will not mislead or misdirect
39 the motorist.

40 Where existing pavement markings are to be removed and replaced by other pavement
41 markings, do not begin removal until adequate provisions have been made to complete
42 the installation of the replacement markings. Remove pavement markings such that the
43 surface is in proper condition for adequate bonding of the new markings.
44 Promptly remove any material deposited on the pavement as a result of
45 removing pavement markings as the work progresses by acceptable methods.

1 Provide the equipment necessary to control dust and the accumulation of debris resulting
 2 from the removal process. The removal equipment shall provide dust control and the
 3 capture of the removed material shall be done using a separate vacuum equipped vehicle
 4 or other approved system. Perform the recovery process within the same operation as the
 5 removal. Do not let traffic use the lane where the removal is taking place until the
 6 recovery system is finished. Should the recovery system fail, cease removal operations
 7 until the recovery system is properly operating. The Contractor is responsible for all
 8 cleanup and proper disposal of all removed debris from the project site.

9 When using a grinding method for pavement marking removal, the equipment shall have
 10 multiple heads working in tandem to provide adequate preparation of the surface to
 11 accept the new marking material.

12 Do not apply polyurea pavement markings over existing pavement marking materials.
 13 Polyurea may be installed over existing polyurea only on asphalt as long as the existing
 14 polyurea is bonded. Application over all other existing pavement marking materials will
 15 require at least 95% of the existing pavement marking material to be removed. However,
 16 if one 15 mil application of paint was placed on asphalt pavement less than 6 month old,
 17 do not remove the existing paint pavement markings.

18 Do not apply thermoplastic pavement markings over existing pavement marking
 19 materials. Thermoplastic may be installed over existing thermoplastic on asphalt.
 20 Application over existing pavement marking materials other than thermoplastic will
 21 require the existing pavement marking material to be removed so that at least 85% of the
 22 existing pavement marking surface is removed. Before applying thermoplastic pavement
 23 markings over the existing thermoplastic pavement markings, remove at least 25% of the
 24 oxidized existing thermoplastic. However, if one 15 mil application of paint was placed
 25 on asphalt pavement less than 6 month old, do not remove the existing paint pavement
 26 markings.

27 Use black color #37038 in paint or tape, as determined by Contractor, to cover any
 28 remaining conflicting pavement marking after removal from asphalt pavement surfaces.
 29 Do not use black paint or tape on concrete pavement surfaces. The black paint will not
 30 have a defined shape or edges with a width not exceeding double of the existing lines.

31 **(J) Pavement Marking Installer Qualifications**

32 Ensure at least one member of every pavement marking crew is certified through the
 33 NCDOT Pavement Marking Technician Certification Process. Keep the certification
 34 current throughout the life of the project. A certified crewmember shall be present
 35 anytime this work is being performed. The certified crewmember is not required to be
 36 the same person throughout the life of the contract.

37 **1205-4 THERMOPLASTIC (ALKYD/MALEIC)**

38 **(A) Application Equipment**

39 **(1) General**

40 Use application equipment constructed to assure continuous uniformity in the
 41 thickness and width of the thermoplastic pavement marking. Use application
 42 equipment that provides multiple width settings ranging from 4" to 12" and multiple
 43 thickness settings to achieve the pavement marking thickness ranging from 0.090" to
 44 0.120". Special thickness equipment may be required for in lane or shoulder
 45 transverse rumble strip pavement markings.

46 Do not use spray thermoplastic unless approved by the Signing and Delineation Unit.

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1 (2) Premelting Kettle

2 Use equipment to install hot thermoplastic pavement marking material that includes
3 an oil-jacketed or air-jacketed premelt kettle for uniform heating and melting of the
4 thermoplastic material. Use a kettle that is equipped with an automatic thermostat
5 control device to provide positive temperature control and continuous mixing and
6 agitation of the thermoplastic material. Do not premelt thermoplastic material in
7 handliner type equipment.

8 (3) Applicator Storage Kettle

9 Equip long line pavement marking vehicles with an automatic thermostat control
10 device to maintain the thermoplastic material at the application temperature and
11 provide continuous mixing and agitation of the thermoplastic material during
12 installation. Construct the equipment so that all mixing and conveying parts, up to
13 and including the application apparatus, maintains the thermoplastic pavement
14 marking material at the specified installation temperature and which has a capacity
15 of at least 1,500 lb of molten thermoplastic pavement marking material. Hand
16 transfer is not allowed.

17 Handliner type application vehicles may contain the premelting and applicator
18 storage functions in the same kettle. Agitation and mixing can be done manually.
19 Drag box type and bucket type application is not allowed.

20 Use premelting and applicator storage kettles that meet the requirements of the
21 National Board of Fire Underwriters, the National Fire Protection Association and
22 State and local authorities.

23 (B) Weather Limitations and Seasonal Limitations

24 Do not apply thermoplastic pavement markings on existing or new pavements unless the
25 ambient air temperature and the temperature of the pavement is 50°F or higher.

26 Do not apply thermoplastic pavement markings between the dates specified below:

East of I-95	December 15 and the following March 16
East of I-77 to and including I-95	November 30 and the following April 1
West of and including I-77	November 15 and the following April 16

27 Exception to the above: When traffic is maintained on a portion of roadway and
28 thermoplastic pavement marking will not be placed within 30 calendar days due to
29 seasonal limitations, place pavement marking paint and beads in accordance with
30 Subarticle 1205-8(C).

31 (C) Application

32 Use only thermoplastic markings that are of the hot, machine applied type. Apply
33 alkyd/maleic thermoplastic pavement markings by extrusion methods only. Extrusion
34 may be accomplished using either conventional extrusion equipment or ribbon gun
35 extrusion devices.

36 The stem portion of straight arrows shall be applied in a single pass and the stem portion
37 of turn arrows is to be applied in no more than 2 passes of the application equipment.
38 Arrowheads may be applied by multiple passes of the application equipment, not to
39 exceed 3 passes.

40 Apply drop-on beads uniformly to the surface of the molten thermoplastic material so the
41 beads are partially embedded and at a rate to immediately obtain the minimum
42 reflectance values. Produce in place markings with minimum retroreflective values
43 shown in Table 1205-2, as obtained with a Department approved 30 m mobile or
44 handheld retroreflectometer. Retroreflective measurements will be taken within 30 days
45 after final placement of the pavement marking.

**TABLE 1205-2
REFLECTOMETER REQUIREMENTS
FOR THERMOPLASTIC**

Item	Color	Reflectivity
Standard Glass Beads	White	375 mcd/lux/m ²
	Yellow	250 mcd/lux/m ²

1 Ensure that the marking is uniformly retroreflective upon cooling and has the ability to
2 resist deformation caused by traffic throughout its entire length.

3 A thin layer of interim pavement marking paint at the proper width may be placed before
4 installing the thermoplastic markings. If this option is chosen, when not specified in the
5 plans or by the Engineer, direct payment for the paint will not be made. Cover any such
6 thin layer of pavement marking paint with thermoplastic pavement marking within
7 30 calendar days of placement. Apply the thin layer of pavement marking paint and
8 beads at the rate necessary to produce a dry film thickness of 5 to 8 mils. Apply drop-on
9 glass beads at a rate of 1 to 3 lb/gal of paint.

10 Provide drainage openings at intervals of 250 ft in edge lines placed on the inside of
11 curves and in edge lines on the low side of tangents. Provide openings that are no more
12 than 12" and at least 6" in length.

13 Produce a cross-sectional thickness of the thermoplastic markings above the surface of
14 the pavement in accordance with Table 1205-3.

**TABLE 1205-3
THICKNESS REQUIREMENTS**

Thickness	Location
240 mils	In-lane and shoulder-transverse pavement markings (rumble strips) may be placed in 2 passes.
120 mils	Center lines, skip lines, transverse bands, mini-skip lines, characters and crosswalk lines.
90 mils	Edge lines, gore lines, diagonals and arrow symbols.

15 **(D) Observation Period**

16 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
17 minimum retroreflective values for a 30-day period beginning upon the Engineer's
18 acceptance of all markings on the project. Guarantee retroreflective values of the
19 markings during the 30-day period under the payment and performance bond in
20 accordance with Article 105-17.

21 **1205-5 POLYUREA**

22 **(A) Weather Limitations**

23 Do not apply polyurea pavement markings on existing or new pavements unless the
24 ambient air temperature and the temperature of the pavement is 40°F or higher.

25 **(B) Application**

26 Produce polyurea pavement marking lines that have a minimum dry thickness of 20 mils
27 when placed on concrete and asphalt pavements.

28 Using the polyurea application equipment, apply the pavement marking materials
29 simultaneously. Apply the polyurea resin, mixed at the proper ratio according to the
30 manufacturer's recommendations, to the pavement surfaces within the proper application
31 temperatures as determined by the material manufacturer. Inject reflective glass
32 beads/elements into the molten (liquid) polyurea pavement markings.

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1 Wait at least 15 days before applying polyurea on new asphalt. Place a thin layer of
 2 pavement marking paint at the proper width before applying the polyurea markings
 3 during the 15 day waiting period. Apply the thin layer of pavement marking paint and
 4 beads at the rate necessary to produce a dry film thickness of 5 to 8 mils. Apply drop-on
 5 beads at a rate of 1 to 3 lb/gal of paint. Direct payment for the pavement marking paint
 6 will not be made. Cover any such thin layer of paint with polyurea pavement marking
 7 within 30 calendar days of placement. If paint is placed on concrete before applying
 8 polyurea, remove 100% of the paint before installing polyurea. Payment for the paint and
 9 removal shall be made under Article 1205-10.

10 Apply drop-on beads and/or highly reflective elements uniformly to the surface of the
 11 polyurea material so that the beads are partially embedded and at a rate to immediately
 12 obtain the minimum reflectance values. Produce in place markings with minimum
 13 retroreflective values shown in Table 1205-2, as obtained with a Department approved
 14 30 m mobile or handheld retroreflectometer. Retroreflective measurements will be taken
 15 within 30 days after final placement of the pavement marking.

16 Produce marking that, upon curing, is uniformly reflectorized and has the ability to resist
 17 deformation caused by traffic throughout its entire length.

18 The Contractor shall be certified by the manufacturer of the polyurea pavement marking
 19 material to install the manufacturer’s material. Provide at least one member of each crew
 20 that completed this training. Furnish the Engineer written confirmation of the training
 21 from the material manufacturer before beginning work. Ensure the manufacturer’s
 22 technical representative, or the manufacturer’s certified representative, is onsite during
 23 the entire installation of the product.

24 **(C) Observation Period**

25 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
 26 minimum retroreflective values for a 30-day period beginning upon the Engineer’s
 27 acceptance of all markings on the project. Guarantee retroreflective values of the
 28 markings during the 30-day period under the payment and performance bond in
 29 accordance with Article 105-17.

TABLE 1205-4 REFLECTOMETER REQUIREMENTS FOR THERMOPLASTIC		
Item	Color	Reflectivity
Standard Glass Beads	White	375 mcd/lux/m ²
	Yellow	250 mcd/lux/m ²
Highly Reflective Elements	White	800 mcd/lux/m ²
	Yellow	500 mcd/lux/m ²

30 If polyurea with highly reflective elements is snowplowed during the 30 day period, the
 31 polyurea pavement marking materials shall meet the minimum retroreflective values in
 32 Table 1205-5.

TABLE 1205-5 REFLECTOMETER REQUIREMENTS FOR THERMOPLASTIC		
Item	Color	Reflectivity
Highly Reflective Elements	White	375 mcd/lux/m ²
	Yellow	250 mcd/lux/m ²

1 **1205-6 COLD APPLIED PLASTIC**

2 **(A) Application Equipment**

3 Use mechanical application equipment, defined as a mobile pavement marking machine
4 specifically designed for use in applying pressure sensitive pavement marking tape of
5 varying widths up to 12". Use an applicator equipped with rollers to provide initial
6 adhesion of the preformed, pressure sensitive marking tape with the pavement surface.
7 Symbols and legends may be tamped by hand but shall be rolled with a weighted roller as
8 per the manufacturer's recommendations. Tamp the cold applied plastic pavement
9 marking material with a 200 lb weighted roller as per the manufacturer recommendations.

10 Surface preparation adhesive may be required depending on the type of cold applied
11 plastic. Refer to the manufacturers' specifications before applying cold applied plastic.

12 Most overlay tape installations should be conducted at an ambient air temperature of
13 60°F and rising and a surface temperature of 70° F with an overnight temperature at
14 least 40°F the night before application. Check the manufacturer's specifications for
15 actual requirements. Install cold applied plastic pavement markings at ambient air
16 temperature and pavement surface temperature per manufacturer's specifications. Wait
17 at least 24 hours after a rain before applying cold applied plastic pavement marking.

18 Cold applied plastic pavement markings shall be between 15 to 90 mils thick.

19 **(B) Types of Cold Applied Plastic**

20 At the time of installation, cold applied plastic pavement markings shall meet
21 Table 1205-4.

Type	Color	Reflectivity
Type 1 - Permanent Standard Tape	White	400 mcd/lux/m ²
	Yellow	300 mcd/lux/m ²
Type 2 - Permanent High Performance Tape	White	500 mcd/lux/m ²
	Yellow	300 mcd/lux/m ²
Type 3 - Permanent Wet Reflective High Performance Tape (Wet)	White	250 mcd/lux/m ²
	Yellow	250 mcd/lux/m ²
Type 3 - Permanent Wet Reflective High Performance Tape (Dry)	White	500 mcd/lux/m ²
	Yellow	300 mcd/lux/m ²
Type 4 - Removable Tape	White	700 mcd/lux/m ²
	Yellow	400 mcd/lux/m ²

22 Type 1 is typically a 2 year life cycle permanent tape used on roadways with an ADT
23 of 5,000 or less.

24 Type 2 material may come as one piece with a black border with yellow or white in the
25 center. Type 2 is typically a 5 year permanent tape used on roadways with an ADT
26 greater than 5,000.

27 Type 3 wet reflective tape shall meet Table 1205-4 retroreflective values, both wet and
28 dry. The value measured under wet conditions shall be measured in accordance with
29 [ASTM E1710](#) when using a portable retroreflectometer and in accordance with
30 [ASTM E2176](#).

Section 1205

1 (C) Observation Period

2 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
3 minimum retroreflective values for a 30-day period beginning upon the Engineer's
4 acceptance of all markings on the project. Guarantee retroreflective values of the
5 markings during the 30-day period under the payment and performance bond in
6 accordance with Article 105-17.

7 **1205-7 HEATED-IN-PLACE THERMOPLASTIC**

8 (A) Application Equipment

9 Apply heated-in-place thermoplastic using a propane blow torch and other material as
10 recommended by the manufacturer.

11 (B) Weather Limitations

12 Apply heated-in-place thermoplastic only when ambient air temperature and pavement
13 surface temperature is 32°F and rising.

14 (C) Applications

15 Apply heated-in-place thermoplastic per manufacturer's specifications. The
16 manufacturer shall certify the installer of heated-in-place thermoplastic.

17 The Contractor may choose to use heated-in-place thermoplastic symbols, characters and
18 transverse lines instead of molten thermoplastics pavement markings.

19 Produce a cross sectional thickness of installed heated-in-place thermoplastic markings
20 above the surface of the pavement after installation and upon cooling in accordance with
21 Table 1205-3.

22 For initial minimum retroreflective value requirements, see Subarticle 1205-4(C).

23 (D) Observation Period

24 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
25 minimum retroreflective values for a 30-day period beginning upon the Engineer's
26 acceptance of all markings on the project. Guarantee retroreflective values of the
27 markings during the 30-day period under the payment and performance bond in
28 accordance with Article 105-17.

29 **1205-8 PAINT**

30 (A) Application Equipment

31 The equipment to apply paint to pavements shall be a truck mounted pneumatic or airless
32 spray machine with suitable arrangements of atomizing nozzles and controls to obtain the
33 specified markings. Paint pavement markings application equipment shall be capable of
34 placing double solid lines, single solid lines, intermittent skip lines or a combination of
35 solid and intermittent skip lines in a single pass. This equipment shall also have
36 an internal timing mechanism for measurement and controlled output of required line
37 lengths.

38 The paint applicator equipment shall have at least two paint tanks with a minimum
39 60 gallon capacity and one tank for glass beads with at least 500 lb capacity. The spray
40 guns used for hand held paint pavement marking application shall be operable from the
41 application truck. All metal parts that hold or transfer paint pavement marking material
42 shall be stainless steel. The paint trucks shall be equipped with quick action valves. The
43 required gauges and pressure regulators shall be conveniently located and in full view
44 and reach of the operator. Paint strainers are required in paint supply lines.

1 The paint applicator shall be equipped with a dispenser for the glass beads as described in
 2 Subarticle 1205-3(B)(2). Provide a glass bead dispenser that operates automatically and
 3 simultaneously with the paint applicator through the same mechanism and that is capable
 4 of adjustment and designed to provide uniform flow over the full length and width of the
 5 stripe as specified in Subarticle 1205-3(G)(2).

6 Provide spray guns for hand application of detail markings, symbols and legends. A hand
 7 operated push type applicator with a glass bead dispenser may be used of radii and/or
 8 parking spaces.

9 **(B) Weather Limitations**

10 Apply paint only when the ambient air temperature and pavement surface temperatures
 11 are at least 40°F and rising and no more than 160°F.

12 **(C) Application**

13 Final pavement marking applications of paint shall be placed in 2 applications of 15 mils
 14 wet each. Apply the second application of paint upon sufficient drying time of the first.
 15 Each application of paint shall consist of drop-on beads applied at a rate to immediately
 16 obtain the minimum retroreflective values.

17 When paint is required by the Engineer or Traffic Control Plan for temporary pavement
 18 markings during temporary traffic patterns, apply one application of paint at 15 mils wet.
 19 If the temporary traffic pattern will last longer than 6 months, apply a second application
 20 of paint 6 months after the initial application. Additional applications of paint at 15 mils
 21 wet may be applied every 6 months as directed by the Engineer or Traffic Control Plan.

22 For each 15 mil application of paint, apply drop-on beads uniformly to the surface of the
 23 paint material at a rate to immediately obtain the minimum retroreflective values. At the
 24 time of installation, produce in-place markings with the minimum retroreflective values
 25 shown in Table 1205-5, as obtained with a Department approved 30 m mobile or
 26 handheld retroreflectometer. Maintain the retroreflective values shown in Table 1205-5
 27 for at least 30 days from the time of placement of the marking material.

TABLE 1205-7 REFLECTOMETER REQUIREMENTS FOR PAINT		
Item	Color	Reflectivity
Standard Glass Beads	White	225 mcd/lux/m ²
	Yellow	200 mcd/lux/m ²

28 Make sure that the marking is uniformly retroreflectorized upon drying.

29 **(D) Observation Period**

30 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
 31 minimum retroreflective values for a 30-day period beginning upon the Engineer's
 32 acceptance of all markings on the project. Guarantee retroreflective values of the
 33 markings during the 30-day period under the payment and performance bond in
 34 accordance with Article 105-17.

35 **1205-9 MAINTENANCE**

36 Replace pavement markings that prematurely deteriorate, fail to adhere to the pavement, lack
 37 reflectorization or are otherwise unsatisfactory during the life of the project or during the
 38 12 month observation period as determined by the Engineer.

39 Upon notification from the Engineer, winterize the project by placing an initial or additional
 40 application of paint pavement marking lines in accordance with Article 1205-8.

Section 1205

1205-10 MEASUREMENT AND PAYMENT

____ *Pavement Marking Lines* will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily placed and accepted by the Engineer. In addition, *Paint Pavement Marking Lines* will be paid per linear foot for each 15 mil application placed in accordance with Subarticle 1205-8(C). The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet derived by multiplying the nominal length of a line by the number of marking lines satisfactorily placed.

____ *Pavement Marking Symbols* will be measured and paid as the actual number of pavement marking symbols satisfactorily placed and accepted by the Engineer. In addition, *Paint Pavement Marking Symbols* will be paid for each 15 mil application placed in accordance with Subarticle 1205-8(C).

____ *Pavement Marking Characters* will be measured and paid as the actual number of characters satisfactorily placed and accepted by the Engineer. A character is considered to be one letter or one number of a word message. In addition, *Paint Pavement Marking Characters* will be paid for each 15 mil application placed in accordance with Subarticle 1205-8(C).

Removal of Pavement Marking Lines will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily removed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet derived by multiplying the nominal length of a line by the number of marking lines satisfactorily removed. No payment will be made for the removal of removable pavement marking tape.

Removal of Pavement Marking Symbols & Characters will be measured and paid as the actual number of pavement marking symbols and characters satisfactorily removed and accepted by the Engineer.

Curing Compound Removal, Lines will be measured and paid as the actual number of linear feet of pavement surface from which the curing compounds are satisfactorily removed. All other surface preparation will be incidental to the work covered by this section. Measurement will be made along the surface of the pavement.

Curing Compound Removal, Symbols & Characters will be measured and paid as the actual number of symbols and characters for which the curing compound has been satisfactorily removed. All other surface preparation will be incidental to the work covered by this section.

Payment at the contract unit price for the various items in the contract will be full compensation for all the items covered by this section. No direct payment will be made for: the work involved in applying the lines, including surface preparation; reapplication of molten pavement marking crossed by a vehicle; removal of all pavement marking materials spilled on the roadway surface; and repair of markings tracked by a vehicle.

Premarking will be incidental to other items in the contract. Unless directed by the Engineer, there will be no direct payment for interim paint. No direct payment will be made for black paint or tape.

The 5 to 8 mils of paint installed before placing the polyurea will be incidental to the work of this section.

The Contractor may choose to use heated-in-place thermoplastic symbols, characters and transverse lines instead of molten thermoplastics pavement markings at no additional cost to the Department.

1 Replacement of pavement markings that prematurely deteriorated, failed to adhere to the
 2 pavement, lacked reflectorization or were otherwise unsatisfactory during the life of the
 3 project or during the 12 month observation period as determined by the Engineer will be at no
 4 cost to the Department.

5 Payment for Paint Pavement Marking Lines required to winterize the project will be made in
 6 accordance with Article 1205-10 except that no payment will be made on resurfacing projects
 7 where paving is completed more than 30 days before the written notification by the
 8 Department that winterization is required.

9 Payment will be made under:

Pay Item	Pay Unit
Paint Pavement Marking Lines, __"	Linear Foot
Thermoplastic Pavement Marking Lines, __", __ mils	Linear Foot
Polyurea Pavement Marking Lines; __"	Linear Foot
Cold Applied Plastic Pavement Marking Lines, Type ____ (__)	Linear Foot
Heated-In-Place Thermoplastic Pavement Marking Lines, __", __ mils	Linear Foot
Paint Pavement Marking Symbols	Each
Thermoplastic Pavement Marking Symbols, __ mils:	Each
Cold Applied Plastic Pavement Marking Symbols, Type ____	Each
Heated-In-Place Thermoplastic Pavement Marking Symbols, __ mils	Each
Paint Pavement Marking Characters	Each
Thermoplastic Pavement Marking Characters, __ mils	Each
Cold Applied Plastic Pavement Marking Characters, Type ____	Each
Heated-In-Place Pavement Marking Characters __ mils	Each
Removal of Pavement Marking Lines, __"	Linear Foot
Removal of Pavement Marking Symbols & Characters	Each
Curing Compound Removal, Lines	Linear Foot
Curing Compound Removal, Symbols & Characters	Each

10 **SECTION 1250**
 11 **PAVEMENT MARKERS GENERAL REQUIREMENTS**

12 **1250-1 DESCRIPTION**

13 Furnish and place pavement markers in accordance with the contract.

14 **1250-2 MATERIALS**

15 **(A) General**

16 Refer to Division 10.

Item	Section
Pavement Markers	1086

17 **(B) Material Qualifications**

18 Use pavement markers that are on the NCDOT Approved Products List.

Section 1250

1 (C) Historical Performance

2 Historical performance of the pavement markers will be used in determining future use of
3 the pavement markers by the Department, even if the pavement markers have been traffic
4 qualified. Poor performance of pavement markers at any site, whether or not related to
5 a specific contract may be grounds for nonacceptance of a product on any project under
6 contract.

7 1250-3 CONSTRUCTION METHODS

8 (A) Weather Limitations

9 Do not install pavement markers or replacement reflectors if moisture tests performed on
10 the pavement indicate the presence of moisture on the pavement surface or on the
11 pavement marker. Install all pavement marker adhesives as required by the
12 manufacturer's specifications for weather and temperature limitations.

13 (B) Preparing for installation

14 Ensure that the pavement, pavement markers and replacement lens are free of dirt, dust,
15 oil, grease, moisture, curing compound, loose or unsound layers or any other material that
16 would interfere with proper bonding of the marker to the pavement or the lens to the
17 marker. Use methods approved by the Engineer for this preparation.

18 (C) Removal of Existing Pavement Markers

19 Remove existing pavement markers before overlaying an existing roadway with
20 pavement. Repair the pavement by filling holes as directed. When traffic patterns are
21 changed, remove pavement markers that conflict with the new traffic pattern before
22 switching traffic to the new traffic pattern.

23 Properly dispose of the removed pavement markers. No direct payment will be made for
24 removal of existing pavement markers or repair of pavement, as such work will be
25 incidental to other items in the contract.

26 (D) Installation

27 (1) General

28 Install all pavement markers and adhesives per manufacturer's specifications.

29 (2) Color

30 Ensure that the color of the reflector corresponds to the pavement marking that the
31 marker supplements. Red reflectors may be required in combination with crystal or
32 yellow reflectors to indicate wrong way movement when viewed in the direction
33 opposing the flow of traffic.

34 (3) Appearance

35 Remove any adhesive from the reflective lens of the marker; otherwise, replace the
36 reflector lenses of a snowplowable pavement marker or the entire raised pavement
37 marker.

38 (4) Spacing

39 Space pavement markers as shown in the plans. Position pavement marker lenses
40 perpendicular to the flow of traffic as shown in the *Roadway Standard Drawings*.
41 Adjust marker longitudinal spacing up to 1 foot in either direction and/or adjust
42 marker lateral spacing up to 3" to avoid installation of the marker at a pavement
43 construction joint or surface defect. If a marker can not be relocated as described
44 above, do not install the affected marker.

(E) Pavement Marker Installer Qualifications

Ensure at least one member of every pavement marker crew is certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. A certified crewmember shall be present anytime this work is being performed. The certified crewmember is not required to be the same person throughout the life of the contract.

**SECTION 1251
RAISED PAVEMENT MARKERS**

1251-1 DESCRIPTION

Furnish, install, maintain and remove temporary and permanent raised pavement markers in accordance with the contract.

1251-2 MATERIALS

Refer to Division 10.

Item	Section
Temporary Raised Pavement Markers	1086-1
Permanent Raised Pavement Markers	1086-2

Use pavement markers that are on the NCDOT Approved Products List.

1251-3 CONSTRUCTION METHODS

Install temporary raised pavement markers on the nonfinal pavement surfaces with epoxy, pressure sensitive adhesives or hot bitumen adhesives.

Install permanent raised pavement markers using a hot bitumen adhesive in accordance with Article 1081-7.

On final pavement surfaces, install temporary raised pavement markers using a pressure sensitive adhesive or hot bitumen adhesive. When using a pressure sensitive adhesive, install a primer/sealer when required by the manufacturer's specifications.

1251-4 MAINTENANCE

Maintain all installed temporary raised pavement markers. Replace all damaged or missing temporary raised pavement markers if any of the following occurs:

(A) Three segment failures occur in any roadway section. Three consecutive damaged or missing markers in any group of 7 represents a segment failure.

(B) Twenty percent of the markers in any roadway section are damaged or missing.

(C) Engineer determines replacement is necessary.

Maintain all installed permanent raised pavement markers until final acceptance of the project.

1251-5 MEASUREMENT AND PAYMENT

Temporary Raised Pavement Markers will be measured and paid as the actual number of temporary raised pavement markers satisfactorily placed and accepted by the Engineer.

Permanent Raised Pavement Markers will be measured and paid as the actual number of permanent raised pavement markers satisfactorily placed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Temporary Raised Pavement Markers	Each
Permanent Raised Pavement Markers	Each

Section 1253

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SECTION 1253
SNOWPLOWABLE PAVEMENT MARKERS

1253-1 DESCRIPTION

Furnish, install and maintain snowplowable pavement markers in accordance with the contract.

1253-2 MATERIALS.

Refer to Division 10.

Item	Section
Snowplowable Pavement Markers	1086-3

Use pavement markers that are on the NCDOT Approved Products List.

1253-3 CONSTRUCTION METHODS

(A) General

Bond marker castings to the pavement with epoxy adhesive. Mechanically mix and dispense epoxy adhesives as required by the manufacturer's specifications. Place the markers immediately after the adhesive has been mixed and dispensed.

Install snowplowable pavement marker castings into slots sawcut into the pavement. Make slots in the pavement to exactly duplicate the shape of the casting of the snowplowable pavement markers.

Promptly remove all debris resulting from the saw cutting operation from the pavement surface. Install the marker castings within 7 calendar days after sawcutting slots in the pavement. Remove and dispose of loose material from the slots by brushing, blow cleaning or vacuuming. Dry the slots before applying the epoxy adhesive. Fill the cleaned slots totally with epoxy adhesive flush with the surface of the existing pavement. Install snowplowable pavement markers according to the manufacturer's recommendations.

Protect the snowplowable pavement markers until the epoxy has initially cured and is track free.

(B) Reflector Replacement

In the event that a reflector is damaged, replace the damaged reflector by using adhesives and methods recommended by the manufacturer of the markers and approved by the Engineer. This work is considered incidental to the installation and maintenance of snowplowable markers specified in this section.

(C) Recycled Snowplowable Pavement Marker Castings

Use properly refurbished snowplowable pavement marker castings as approved by the Engineer such that approved new reflectors can be installed inside the castings.

1253-4 MAINTENANCE

Maintain all installed snowplowable raised pavement markers before acceptance.

1253-5 MEASUREMENT AND PAYMENT

Snowplowable Pavement Markers will be measured and paid as the actual number of snowplowable pavement markers satisfactorily placed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Snowplowable Pavement Marker	Each

**SECTION 1264
OBJECT MARKERS**

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3 **1264-1 DESCRIPTION**

4 Furnish and install object markers in accordance with the contract.

5 **1264-2 MATERIALS**

6 Refer to Division 10.

Item	Section
Object markers	1088-4
U-channel posts	1094-1(B), 1094-1(C)
Joint Sealer	1028-2

7 Use pavement markers that are on the NCDOT Approved Products List.

8 **1264-3 CONSTRUCTION METHODS**9 Use Type 1 object markers to mark obstructions within the roadway. Mount on sign supports
10 to supplement a sign, or mount individually on 7 ft U-channel posts, or mount on the actual
11 obstruction.12 Use Type 2 object markers to mark obstructions that are not in the roadway. Mount
13 Type 2 object markers on the back of sign supports located in the median of divided
14 roadways, and the outside of two-lane, two-way roadways where the sign is facing the
15 opposing traffic direction. Place Type 2 object markers on the side nearest the traffic
16 approaching the back of the sign supports. If guardrail is used to protect the sign supports, or
17 where 2 signs are mounted back to back, Type 2 object markers are not required.18 Use Type 3 object markers to mark larger obstructions within or outside the roadway, such as
19 bridge piers, abutments, rails, culvert headwalls or narrow shoulder drop-offs. Ensure the
20 stripes slope downward toward the side of the obstruction on which traffic is to pass. They
21 may be required to be mounted on the actual obstruction or individually on 7 ft U-channel
22 posts.23 Mount end of road object markers on 7 ft U-channel posts at the end of a roadway where there
24 is no alternate vehicular path.25 **1264-4 MEASUREMENT AND PAYMENT**26 *Object Markers (Type ____)* will be measured and paid as the actual number of object
27 markers satisfactorily placed and accepted by the Engineer28 *7' U-Channel Posts* will be measured and paid as the actual number of 7 ft U-channel posts
29 satisfactorily placed and accepted by the Engineer.

30 Payment will be made under:

Pay Item	Pay Unit
Object Markers (Type 1)	Each
Object Markers (Type 2)	Each
Object Markers (Type 3)	Each
Object Markers (End of Road)	Each
7' U-Channel Posts	Each

Section 1266

**SECTION 1266
TUBULAR MARKERS (FIXED)**

1266-1 DESCRIPTION

Furnish, install, relocate, maintain and remove tubular markers in accordance with the contract.

1266-2 MATERIALS

Refer to Division 10.

Item	Section
Tubular Markers	1088-7

Use pavement markers that are on the NCDOT Approved Products List.

1266-3 CONSTRUCTION METHODS

Secure tubular markers to the pavement surfaces using epoxy or other approved types of adhesives.

Use tubular markers affixed to pavement surfaces as a supplement to pavement markings to channelize traffic. Use tubular marker such that the color of the tubular marker and retroreflective sheeting would match the color of the pavement markings they supplement, except as noted below:

(A) Use yellow tubular markers with white and crystal retroreflective sheeting on top of asphalt islands as shown in the plans.

(B) Use orange tubular markers affixed to pavement surfaces with white and crystal retroreflective sheeting to separate opposing traffic placed on one side of a 4 lane divided highway.

(C) Gray tubular markers with white/crystal retroreflective sheeting may be used to supplement white pavement markings.

1266-4 MAINTENANCE

Inspect and replace any worn out tubular markers at no cost to the Department.

Inspect and replace all damaged or missing tubular markers if any of the following occurs in accordance with Article 1266-5:

(A) Three segment failures occur in any roadway section. Two consecutive damaged or missing tubular markers in any group of 7 represents a segment failure

(B) Twenty percent of the total numbers of tubular markers in any roadway section are damaged or missing.

(C) Engineer determines replacement is necessary.

1266-5 MEASUREMENT AND PAYMENT

Tubular Markers (Fixed) will be measured and paid as the maximum number of tubular markers satisfactorily placed and accepted by the Engineer at any one time during the life of the project.

Payment will be made under:

Pay Item	Pay Unit
Tubular Markers (Fixed)	Each

SECTION 1267
FLEXIBLE DELINEATORS

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1267-1 DESCRIPTION

Furnish and install flexible delineators in accordance with the contract.

1267-2 MATERIALS

Refer to Division 10.

Item	Section
Flexible Delineators	1088-8

Use pavement markers that are on the NCDOT Approved Products List.

1267-3 CONSTRUCTION METHODS

Use yellow, red or crystal retroreflective sheeting as shown in the plans. Place the retroreflective sheeting on the front and back of the delineator post as required by the plans.

Install the delineator post so that the entire width of the retroreflective sheeting is visible to approaching traffic.

Install the delineator post so the top of the reflective sheeting is 48" above the near edge of roadway surface.

Install the delineator post and base support according to the manufacturer's specifications.

Install the flexible delineators plumb on all sides.

Provide a post such that both sides of the top of the post accepts and holds securely, retroreflectorized sheeting. The color of the post shall be gray.

Install the post such that the post length provides for adequate ground penetration for proper performance.

Attach the flexible delineator post to the base support using 2 hex head bolts, flat washers, lock washers and deformed thread hex nuts. Tighten the bolts to at least 20 ft-lb torque.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in median and on the left side of one-way ramps, loops or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, use delineators whose colored retroreflective sheeting supplements the color of the adjacent edgeline.

Design the delineator post for a permanent installation to resist overturning, twisting and displacement from wind and impact forces.

1267-4 MAINTENANCE

Maintain all installed flexible delineators before acceptance.

1267-5 MEASUREMENT AND PAYMENT

Flexible Delineators (color) will be measured and paid as the actual number of flexible delineators satisfactorily installed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Flexible Delineator (Crystal)	Each
Flexible Delineator (Yellow)	Each
Flexible Delineator (Crystal and Red)	Each
Flexible Delineator (Yellow and Red)	Each

DIVISION 14 LIGHTING

SECTION 1400 ROADWAY LIGHTING

1400-1 DESCRIPTION

Furnish, install, connect and place into satisfactory operating condition lighting at locations shown in the plans. Perform all work in accordance with the contract and the National Electrical Code.

This division is for methods, materials and equipment to construct and put in working order the proposed lighting; however, every fitting, minor detail, or feature may not be shown or described. The Contractor shall be an expert in the trade, capable of understanding the intent of the contract and constructing the lighting and electrical system(s) in accordance with the best practice of the trade.

The Contractor actually performing the work described in the contract shall have a license of the proper classification from the North Carolina State Board of Examiners of Electrical Contractors.

Have the licensed Contractor available on the job site as necessary when work is being performed or when requested by the Engineer. Have this Contractor possess a set of project plans and Specifications on the job site and maintain a set of accurate as built plans. This Contractor shall be qualified to responsibly instruct and direct all employees regarding the electrical work.

1400-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3
Ground Rod	1091-6
Wire	1091-2

(A) General

All materials used in the work are to be new materials unless noted elsewhere in the contract. References in the contract to any proprietary device, product, material, fixture, form, type of construction, etc. by make or catalog number, with or without the words or approved equal, is to be taken as establishing a standard of quality and is not to be construed as limiting competition. In such case, the Contractor may use any material, equipment or type of construction which has written approval as being an acceptable equal to that named for the particular use intended by the contract.

Provide materials that are labeled or listed by an acceptable organization, which is defined as an organization that maintains periodic inspection of the production of the materials and verifies, by the labeling or listing procedure, that the materials comply with appropriate standards of performance or are suitable for use in a specified manner. Provide Underwriters' Laboratories (UL) labeled and listed materials when such labeling and listing is available for such materials.

Make sure that materials are in compliance with requirements for use of domestic products, as specified in other sections of the Specifications.

Section 1400

1 (B) Conduit

2 Use conduit and duct that is either metallic (Rigid Metallic Conduit) or non-metallic
3 (PVC or HDPE), as noted in the plans.

4 (C) Wire

5 Use stranded copper conductors unless specifically noted otherwise on the contract. Use
6 wire and cable which conforms to IPCEA specifications and has marks for identification
7 (manufacturer's name, type insulation and gauge of conductor) and the UL label.

8 Use wire insulation rated at 600 VAC or greater.

9 Use the following types of wiring unless noted otherwise in the plans:

Service Lateral	UL Type USE
Control System	UL Type THW or RHW or THHN
Feeder Circuits in Conduit	UL Type USE
Branch Circuits in Light Standards	UL Type SO Cable
Equipment Grounding Conductor	Solid MHD, Bare or Insulated
Grounding Electrode Conductor	ASTM B2

10 Use #6 AWG for the grounding electrode conductor unless noted larger in the plans.

11 (D) Grounding and Bonding Equipment

12 Use ground rods which are 5/8" diameter x 10 ft copper clad steel. Permanently bond
13 grounding conductor to ground rod using exothermic weld. Make sure that all grounding
14 and bonding equipment conforms to UL Standard 467.

15 (E) Fuseholders

16 Provide fused overcurrent protection in the base of each light standard and other locations
17 as noted. Use a fuseholder rated at least 600 VAC and 30 A approved for wet locations,
18 constructed so the fuse will be disconnected from the line side power every time the
19 fuseholder is opened. The fuseholder may be made of molded plastic or rubber and have
20 insulating boots. Use terminals which are specifically rated for the size and number of
21 conductors required.

22 Use fuses which have 5,000 A minimum interrupting capacity at the supply voltage, are
23 rated 10 A or as noted in the plans and are not glass type unless specified different in the
24 contract. Use the same type fuse in all fuseholders on a project unless specified
25 differently at specified locations.

26 Use fuseholders specifically designed as breakaway devices in fiberglass standards and
27 standards with breakaway bases. Use fuseholders designed to disconnect line side power
28 without damage to the terminals or conductors every time sufficient pulling force is
29 placed on the line and load side conductors.

30 (F) Hardware

31 Use mounting or attachment hardware including bolts, nuts, washers, straps, clamps and
32 hangers which is made of stainless steel, hot dipped galvanized or of equal corrosion
33 resistance. Use bolts, which are minimum length and are not less than one nominal size
34 smaller than the opening being used.

35 (G) Lamps

36 Use lamps that conform to ANSI specifications, are of the type and wattage indicated on
37 the contract, are rated for a minimum of 24,000 hours life, have a mogul base and have
38 special coatings for premium efficiency and color rendition. Provide and install same
39 type lamps for all same type luminaires furnished on the project.

1 (H) Duct and Conduit Sealer

2 Use duct and conduit sealer or mastic which is a putty-like compound and complies with
3 the following:

- 4 (1) Is permanently non-hardening, non-oxidizing and non-corrosive to metals, rubber,
5 plastic, lacquer and paints;
- 6 (2) Is readily workable for thumbing into openings and forming into seals around wires
7 inside conduits and openings around conduits;
- 8 (3) Has a service temperature range of minus 30°F to 200°F;
- 9 (4) Is clean, non-poisonous and non-injurious to human skin; and
- 10 (5) Seals against water, dust and air and shall adhere to wood, glass, plastics, metal,
11 rubber and painted surfaces.

12 (I) Pull Lines

13 Place pull lines specifically designed for pulling a rope in all empty conduits and
14 electrical duct so that electrical circuits can be installed in the future. Use pull lines
15 which are 2 ply with a tensile strength of at least 240 lb and resistant to tangling, rot and
16 mildew.

17 1400-3 SUBMITTALS**18 (A) Catalog Cuts**

19 Submit for approval catalog cuts and/or shop drawings for materials proposed for use on
20 the project. Allow 40 days for review of each submittal. Do not deliver materials which
21 have not been approved to the project. Submit 8 copies of each catalog cut and/or
22 drawing and show for each the material description, brand name, stock-number, size,
23 rating, manufacturing specification and the intended use.

24 Three copies of approved submittals will be returned to the Contractor. Present a catalog
25 cut or drawing for all components of each contract item. Present the submittals neatly
26 arranged in the same order as the contract bid items.

27 (B) Certifications

28 Furnish a Type 3 material certification in accordance with Article 106-3 for light
29 standards, high mounts and lowering devices and a Type 6 material certification for
30 conductors. Submit certifications when the above materials are delivered to the project.

31 Type 3 or Type 6 material certifications in accordance with Article 106-3 may be
32 requested for any or all of the other material which does not have a name plate showing
33 sufficient information to verify that the material was manufactured to the requirements of
34 this section.

35 (C) Samples

36 Random samples will be taken of the various items for the purpose of verifying
37 conformance with Specifications. The selection of the items to be sampled and the taking
38 of the samples will be done by the Engineer.

39 Failure to meet specification requirements by 2 samples of any material will be sufficient
40 reason for rejection of all materials from the same lot.

41 Upon request, there will be reimbursement for the actual verified cost of such material
42 taken as samples, including any handling charges less any discount allowed on the
43 invoice, but with no percentage added, and such material will thereafter become the
44 property of the Department.

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1 (D) As-Built Plans

2 Submit 2 complete sets of as-built plans for review upon completion of the work,
3 showing the location of all buried electrical circuits, with pavement crossings
4 dimensioned from fixed objects or from survey stations.

5 Include in the as-built plans the title (No. 1), index (No. 1A), summary of
6 quantities (No. 3) and all of the layout and detail (E) sheets of the project with all changes
7 indicated. After review and approval, place one set of these as-built plans in a waterproof
8 envelope and file in each control panel.

9 Submit one set of as-built plans to the Roadway Design Unit.

10 Show the light standard foundations that are relocated (by permission of the Engineer) on
11 the as-built plans in their final locations.

12 Keep a daily record of the location of all items in order to ensure the accuracy of the
13 as-built plans.

14 (E) Warranties

15 Turn over warranties from each manufacturer of electrical materials and equipment
16 pertinent to the complete and satisfactory operation of the system before the acceptance
17 of the project. Indicate the expiration date on each warranty furnished. The warranty
18 shall not be less than those provided as a customary trade practice.

19 (F) Computations and Welding Procedures

20 Submittals of structural design computations and drawings showing material and welding
21 specifications, as required in other sections of the *Standard Specifications* such as High
22 Mount Standards, may require 10 weeks for review.

23 1400-4 CONSTRUCTION METHODS

24 (A) Location Surveys

25 All light standards, high mount foundations and electrical duct will be located unless
26 indicated differently elsewhere in the contract. Mark the proposed location of circuits,
27 circuit markers, control systems, service poles, junction boxes, luminaires and all other
28 components for approval before installation.

29 The plan locations of the light standards and high mounts may be adjusted to be behind
30 guardrail, to avoid obstructions or to avoid undesirable foundation conditions. Ensure
31 location changes are approved before construction. Light standards can be moved no
32 more than 10 ft longitudinally and 2 ft laterally unless approved by the Special Design
33 Section of Roadway Design Unit. High mast light standards can be moved no more than
34 25 ft radially unless approved by the Special Design Section of Roadway Design Unit.

35 Verify project dimensions on the site, actual measurement always taking precedence over
36 scaled plan dimensions, with every part of the work fitted to actual conditions at the site.

37 (B) Damage to Facilities

38 Take all precautions necessary to avoid damage to existing underdrains and other buried
39 facilities located in certain areas. Hand trenching may be required to avoid damage to the
40 underdrains, storm sewer systems and other facilities. Construct light pole foundations
41 with a minimum horizontal clearance of 10 ft to storm sewers or other underground
42 installations which might affect the foundation stability. Make lateral and longitudinal
43 changes in pole locations in the field to provide the required clearance, as directed.

44 Trenching and construction operations may require the removal of, or result in damage
45 to, existing shoulders and paved ditches. Restore all disturbed portions of the project to
46 their original condition or as approved.

1 Installation of conductors may require trenching through existing guardrail locations.
2 Trenching may be done beneath the guardrail in a manner that will not disturb the
3 guardrail installation or the Contractor may remove short sections of guardrail to
4 facilitate mechanical trenching. Reinstall all removed guardrail by the end of the day's
5 work. Permission is required before removal of any guardrail. Repair any damage to the
6 guardrail installation or to the galvanizing of the material as directed.

7 Repair all trenched, excavated, or otherwise damaged earth surface areas by shaping,
8 smoothing, seeding and mulching the damaged areas as required by the Specifications
9 and as directed.

10 **(C) Existing Utilities**

11 Water, sewer, telephone, fire alarm, traffic signal and power lines may be located in the
12 same area that lighting standards and circuits are to be installed.

13 Locate these lines before operations are begun. Field changes approved by the Engineer
14 may be made to provide clearance required by the NESC.

15 Foundations or other construction which is installed in conflict with existing utilities will
16 not be acceptable. Remove unacceptable conflicting construction and repair damage to
17 utilities at no cost to the Department.

18 When the work involves replacing or renovating existing lighting, make all reasonable
19 efforts to prevent dark spots in the lighting system. Phase lighting construction to allow
20 existing lighting to remain in operation as long as possible.

21 **(D) Operation of Equipment**

22 Use a bucket truck to raise workers into position to install and/or adjust luminaires and
23 lamps after the initial setting of the standards. Taking down the light standard to check or
24 make adjustments at the top is not allowed.

25 Install all bore pits outside the clear zone.

26 **(E) Conduit Installation**

27 Install conduit continuous, watertight, free of kinks and make all runs with as few
28 couplings as standard lengths will permit. Do not exceed a total angle of 270° between
29 outlets unless otherwise approved. Conduit bodies with covers and neoprene gaskets
30 may be used to facilitate the installation of the wires at locations indicated in the plans.

31 Provide protection at all times against the entrance of water or other foreign matter into
32 the conduit. Plug or cap conduit when work is temporarily suspended, including nightly
33 stoppage of work.

34 Clean all conduits before installation and upon completion of the system. Snake an
35 approved cleaner with a diameter not less than 85% of the nominal diameter of the
36 conduit through each conduit before installing the wire.

37 Install the conduit in such a manner that temperature changes will not cause elongation or
38 contraction that might damage the system. Provide expansion fittings where conduit
39 crosses structure expansion joints and at other locations shown in the plans.

40 Avoid short radius bends in non-metallic conduit to prevent burn-through of the pulling
41 cable or conductors during pulling operations.

42 Install caps or plugs on stub-outs for future use. Caps and plugs shall be made of the
43 same material as the conduit. Where non-metallic conduit is joined to metallic conduit,
44 use a transition adapter. Install bushings on all conduit ends projecting into panels,
45 boxes, or other enclosures. Provide pull lines in all conduits for future installation of
46 circuitry. Coat field cut threads and other uncoated metal or damaged galvanizing with
47 organic zinc repair paint. Securely fasten conduit. For the spacing of fasteners,

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1 do not exceed 4 ft for 1 1/2" conduit and larger or 6 ft for 1 1/4" conduit and smaller.
2 Use fasteners that are hot dipped galvanized or stainless steel. Provide backs with all
3 conduit straps installed on flat surfaces. Rotary-impact drills may be used for installing
4 expansion anchors in concrete. Do not use powder explosion type units.

5 Do not install underground conduit until the area has been brought to final earth grade.
6 Give careful attention to the vertical and horizontal alignment of the conduit to provide
7 the smoothest installation.

8 (F) Wiring Methods

9 Do not pull wire through a conduit system until the system is complete and has been
10 cleaned. Use approved wire pulling lubricants. Pull conductors by hand, or use
11 motorized cable-pulling equipment designed for pulling multiple cables into conduit.
12 Use sheaves or rollers, as required to prevent damage to conductor insulation. Do not use
13 an automobile to generate cable pulling forces. Use equipment similar to the Greenlee
14 model UT2 cable pulling system, or Engineer approved equal.

15 Color code all conductors per the NEC (grounded neutral is white, grounding is bare or
16 green) and use phase conductors which are black and red. Approved marking tape, paint,
17 or sleeves may be used instead of continuous colored conductors for No. 8 AWG and
18 larger. Do not mark a white conductor in a cable assembly any other color. White, red or
19 black conductor may be stripped at all accessible points and used as a bare equipment
20 grounding conductor.

21 Joints, taps and splices will only be permitted at locations indicated in the plans and by
22 the following method.

23 Install a manufactured set screw type connector, suitable for connecting multiple wires
24 and are UL Listed (UL486D). These precise fit connectors are insulated with high-
25 strength dielectric material and equipped with factory made waterproof insulating boots
26 and removable access plugs over the set screws. These connectors are suitable for use in
27 direct burial and submersible applications. Tape down the access plugs to keep them
28 securely in place. Split-bolt, wire nut and compression type connectors will not be
29 allowed.

30 All splices inside light standards shall be easily accessible through handholes unless
31 standard is mounted on breakaway transformer base.

32 (G) Grounding Electrodes

33 Install grounding electrodes at each light standard, high mast light standard and control
34 system as shown in the plans. The rod shall be driven vertically until the top is 6" below
35 the ground surface. The grounding conductor must be connected to the grounding
36 electrode by exothermic weld.

37 (H) Equipment Mounting

38 Mount equipment securely at locations shown in the plans in conformance with the
39 dimensions shown and make vertically plumb and level. Install fasteners as
40 recommended by the manufacturer and space evenly. Use all mounting holes and
41 attachment points for attaching enclosures to structures.

42 (I) Base Protection

43 For median mounted light standards, use a protective metal shroud installed underneath
44 the light standard base plate to protect the exposed anchor bolts and lighting circuitry
45 segments between the base plate and the top of the concrete median barrier. The metal
46 shroud shall be fabricated of either galvanized steel, minimum gauge 22, or aluminum,
47 minimum gauge 18, to match the material type of the light standard. The metal shroud
48 shall be composed of 2 overlapping pieces, and attached with 2 self-tapping stainless
49 steel or galvanized machine screws at each overlap point.

1 For high mount standard, use galvanized steel welded wire reinforcement between the top
2 of foundation and bottom of mounting base. Attach welded wire reinforcement to anchor
3 bolts with size AWG 14 copper wire or small gauge galvanized wire.

4 **(J) Galvanizing Repair**

5 Repair any damaged galvanized components in accordance with Article 1076-7.

6 **1400-5 ELECTRICAL INSPECTIONS AND TESTING**

7 Comply with all local ordinances and regulations. Apply for and obtain all permits and/or
8 licenses required by local regulation.

9 Provide a calibrated MegOhmMeter, with certification that calibration was done within one
10 year of use. Provide a meter manufactured by Fluke, Amprobe, Biddle or Engineer approved
11 equal. Present the meter for inspection, at the Pre-Lighting-Work meeting described in
12 Section 1400-11.

13 During project construction the Contractor will perform an insulation resistance test on each
14 feeder circuit conductor. The insulation resistance for each conductor shall exceed
15 5 megaohms after charging for 30 seconds at 500 VAC or 1000 VDC. A copy of the
16 Contractor Meg Circuit Data Form is available on the Roadway Design Unit website. The
17 data form will be completed by the Contractor and submitted to the Lighting and Electrical
18 Squad of the Roadway Design Unit for review before final inspection.

19 If the insulation resistance test of any conductor indicates a value of less than 5 megaohms,
20 locate the fault. If the fault is in a conductor between terminal connections, replace the
21 conductor. If the fault is at a terminal connection, repair or replace the terminal device.

22 Removing water from the conduit of a faulty circuit is not considered a repair. Water in the
23 conduit allows electric current to flow between skinned places in the conductors insulation. If
24 a circuit fails the insulation resistance test and removing water allows the circuit to pass,
25 replace the conductors and re-test the new circuit.

26 After all control system cabinet wiring has been installed and connected in the proposed
27 permanent manner the Contractor will contact the Office of State Fire Marshall of the
28 Department of Insurance, or local authority having jurisdiction, to perform an electrical
29 inspection of the lighting system. Upon satisfactory testing, the Contractor will be issued
30 a Certificate of Inspection for the lighting system. The Contractor may then arrange with the
31 power company to provide the necessary power service. The Certificate of Inspection will be
32 turned over to the Engineer before project acceptance. Inspection by local authorities will
33 neither eliminate nor supersede the final inspection by the Engineer to ensure compliance with
34 the contract.

35 Have all work inspected and approved by the Engineer before concealment. An inspection
36 will be made during the progress and after the work has been completed. It will also include
37 an inspection made at night to determine the optical qualities of each luminaire. Adjust all
38 luminaires having unsatisfactory qualities as directed.

39 Provide the necessary personnel and equipment for aiming luminaires during nighttime
40 inspections by the Engineer.

41 The Engineer should contact either the Special Design Section or the Lighting and Electrical
42 Squad of Roadway Design Unit to schedule a final inspection of lighting systems at least
43 2 weeks before the requested inspection date. The Lighting and Electrical Squad will perform
44 an insulation resistance test as described above, inspect the system for adherence to contract
45 requirements and prepare a lighting inspection memo based on the Lighting System
46 Inspection Checklist. A copy of the inspection checklist is available on the Roadway Design
47 Unit's website. The Contractor is responsible for providing the personnel and equipment
48 necessary for removing and replacing fuseholders and/or operating circuit breakers to
49 facilitate the insulation resistance test performed by the Lighting and Electrical Squad.

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1 **1400-6 BURN-IN TEST**

2 After all the issues mentioned in the lighting inspection punchlist are addressed to the
3 satisfaction of the Engineer, the lighting system will undergo a 2-week burn-in test. The
4 burn-in test consists of normal dusk to dawn operation of all lighting system control
5 equipment and apparatus, without interruption or failure attributable to poor workmanship or
6 defective material. At the end of the burn-in test, all lights and equipment will be inspected
7 for normal operation. The Contractor will make any necessary repairs or replacements at no
8 cost to the Department.

9 Conduct the burn-in test at the same time for all lights which are energized from the same
10 utility company service point.

11 Burn-in tests of individual circuits or groups of lights will not be acceptable.

12 **1400-7 IDENTIFICATION**

13 Identify each component of the lighting/electrical system as indicated in the plans. Use
14 a method of identification which includes an approved paint, adhesive label, heat shrink label
15 or embossed concrete. Label conductors on components requiring identification at each
16 terminal, circuit breaker, light standard, high mount standard, control system, junction box
17 and underpass panel.

18 Label each circuit conductor at each terminal and access point with the circuit number
19 indicated in the plans.

20 Identify light standards and high mount standards by the control system and location number
21 indicated in the plans. Put the identification on the front side of the standard facing the traffic
22 at a height of 6 ft above ground level. Identify control systems and underpass panels on the
23 exterior of the front panel.

24 **1400-8 LOCKS AND KEYS**

25 Supply all access doors to control cabinet enclosures with locks that meet the Engineer's
26 approval. Key all locks alike and furnish 8 keys to the Engineer.

27 **1400-9 ELECTRICAL SERVICE**

28 Coordinate all work to ensure that electrical power of the proper voltage, phase, frequency
29 and ampacity is available to complete the project. Contact the utility company, make
30 application, pay all deposits and other costs to provide necessary electrical service. The
31 Contractor will be reimbursed for the actual verified cost of any utility company charges.

32 The Engineer will provide authorization to the Contractor for electrical service to be obtained
33 in the name of the Department and for the monthly power bills to be sent directly from the
34 utility company to the Department. The Department will be responsible for direct payment of
35 monthly power bills received from the utility company.

36 **1400-10 TERMINOLOGY**

37 The terms "High Mast" and "High Mount" are used synonymously in the contract.

38 The term "By Others" means work to be accomplished and paid under contract items other
39 than those clearly pertaining to the work specified or shown. Work by others may be included
40 in this contract for the Contractor to provide, or it may be provided under another contract or
41 by someone other than the Contractor.

42 Abandon means that the materials will not be used in the final completed form of the work.
43 Remove all abandoned materials from the project or terminate at least 18" below subgrade so
44 they will not be in conflict with the finished project.

1 1400-11 CONSTRUCTION PHASING

2 Schedule a Pre-Lighting-Work meeting before beginning work on the lighting system.
 3 Include staff members from the prime contractor, electrical sub-contractor, Resident
 4 Engineer's office and the Lighting and Electrical Squad in the Roadway Design Unit in
 5 Raleigh

6 Accomplish lighting work along with other roadway construction in the appropriate phases as
 7 indicated in the Traffic Control Plans and these Specifications.

8 1400-12 MEASUREMENT AND PAYMENT

9 There will be no direct payment, except where specifically noted in the Subarticle 1400-3(C)
 10 and Article 1400-9 for the work required in the preceding sections of this division. Payment
 11 of the contract unit prices for the various items in the contract will be full compensation for all
 12 work required.

13 1400-13 CONTRACTOR MEG CIRCUIT DATA FORM

14 The Electrical Sub-contractor is responsible for completing the Meg Circuit Form and
 15 submitting the insulation resistance data to the Lighting and Electrical Squad of Roadway
 16 Design Unit for review before final inspection. A copy of the Contractor Meg Circuit Data
 17 Form is available on the Roadway Design Unit's website.

18 1400-14 LIGHTING SYSTEM INSPECTION CHECKLIST

19 The Engineer is responsible for scheduling the lighting system final inspection by contacting
 20 either the Special Design Section or the Lighting and Electrical Squad of the Roadway Design
 21 Unit. The Lighting and Electrical Squad will coordinate with project inspector and electrical
 22 subcontractor to have the checklist items inspected during the final inspection and in
 23 preparation of the lighting inspection punchlist. A copy of the inspection checklist is
 24 available on the Roadway Design Unit's website.

25 **SECTION 1401**
 26 **HIGH MOUNT STANDARD**

27 1401-1 DESCRIPTION

28 Design, furnish and install a high mount standard 60' or greater in height with a top-latched
 29 lowering device and portable drive unit including the drive, winch, wiring, cables, brackets,
 30 hardware, transformer, power cord, storage case and operating manuals.

31 1401-2 MATERIALS**32 (A) High Mount Standard**

33 Provide certified computations and fabrication drawings by a professional engineer
 34 licensed in the State of North Carolina.

35 Design the support including base plate and anchorage in conformance with the *AASHTO*
 36 *Standard Specifications for Structural Supports for Highway Signs, Luminaires and*
 37 *Traffic Signals, Fourth Edition, 2001* and the Interim Specifications valid at the time of
 38 letting. Use Fatigue Category II. Design and fabricate welds in accordance with
 39 Article 1072-18. Design the support for the wind velocity shown in the plans.

40 Have the drawings show all details relating to pole, access hole, base, anchorage and
 41 lowering device. Show references to ASTM specifications or to other material
 42 specifications for each type of material used on the drawings. Note the total weight in
 43 pounds on the drawings for each component and the total assembly. Make sure that all
 44 drawings are clearly identified with a drawing number and signed and dated by the
 45 manufacturer's authorized representative.

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1 Show clearly full and complete information regarding location, type, size and extent of
2 all welds on the drawings. For groove welds, indicate the particular detail and process to
3 be employed in production of the work. For prequalified joints, use of the Structural
4 Welding Code - Steel, AWS D1.1 letter classification designation of the
5 joint (B-L2b-S, etc.) will satisfy this requirement.

6 The standard may be either a multisided or round tubular member.

7 The criteria listed below shall apply to 60-ft, 80-ft, 100-ft and 120-ft high mount light
8 poles:

9 (1) Provide 8 or more anchor rods for each pole.

10 (2) Provide base plate thickness of at least 2.5".

11 (3) Provide welded wire reinforcement for base protection that meets
12 Subarticle 1400-4(I).

13 Furnish 8 copies of complete detailed drawings and one copy of the complete design
14 computations for each height of standard for approval before fabrication.

15 The Contractor's attention is directed to the fact that it will take 10 weeks to secure
16 approval after submission of the complete drawings and computations.

17 Fabricate the support in accordance with the details shown on the approved shop
18 drawings and the Specifications.

19 Test all base plate to upright welds using magnetic particle testing (MPT) before
20 galvanizing. All base plates must be tested at 100%. Radiographically test the
21 longitudinal seam welds within 6" of circumferential welds in the outer tube of the slip fit
22 joint area.

23 Hot dip galvanize metalwork after fabrication has been completed. Ensure the
24 galvanization conforms to ASTM A153 for fasteners and ASTM A123 for other
25 structural steel.

26 Partial penetration longitudinal groove welds on shaft sections, having a minimum throat
27 of 60% of the thickness of material being joined, will be acceptable provided the
28 qualification requirements of the Structural Welding Code - Steel, AWS D1.1 are met.
29 However, full penetration will be required on longitudinal groove welds within 6" of
30 circumferential welds and in areas where a shaft section telescopes over another shaft
31 section. No field welding of any part of the assembly will be permitted.

32 Allow easy access to all components in the base of the standard with a hand hole with
33 a hinged and lockable door. Allow for opening of the door without the use of special
34 tools or wrenches. Make the hand hole large enough for removal of the circuit breaker
35 and the hoist gearbox and winch assembly (at least 9" x 18".) Make the door hinge and
36 lock mechanism sturdy enough to prevent vandalism and to prevent freeze-up or binding
37 due to corrosion or too tight fit. Achieve locking with a conventional padlock. Built-in
38 locks or latching mechanism for the door will not be acceptable.

39 (B) Lowering Device

40 Furnish 8 copies of complete detailed drawings of the lowering device with manuals
41 describing the assembly, erecting and operating procedures. Include precise instructions
42 on stringing the cables and leveling the carrier ring.

1 Each high mount lighting standard shall have a device to lower the luminaires from the
2 operating position at the top of the standard to a service position approximately 3 ft above
3 the base of the standard. Include on the device a head-frame, top latching carrier ring and
4 winch assembly. Design the lowering device for the number of luminaires as shown in
5 the plans, each weighing and each having a projected area in accordance with
6 Section 1403.

7 Mount the head frame on the standard with a slipfitter and set screws, and have sheaves
8 or rollers for the lifting and power cables. Ensure sockets automatically secure the carrier
9 ring at the top in the raised position and provide a hood on the entire assembly for
10 protection from the weather. Attain latching and unlatching by alternately raising and
11 lowering the carrier ring. Use sheaves that are non-corrosive materials with bronze
12 bushings and stainless steel shafts. Provide suitable retainers to assure that the cables
13 stay in correct position.

14 Have slipfitter tenons equally spaced for mounting the luminaires on the carrier ring.
15 Have the carrier ring automatically latched to the head frame when raised into position by
16 suitable pins and sockets which will prevent the luminaires from swaying, turning,
17 vibrating, or otherwise moving out of proper position. Include on the carrier ring spring
18 loaded roller arms to guide the ring during raising and lowering operations. Use springs
19 made of stainless steel and rollers made of nylon. Mount a metal NEMA 3R
20 weatherproof junction box on the ring for connection of individual luminaire circuits to
21 the electrical power supply cable. Include in the junction box a flanged inlet for
22 connection of the power supply cable. Use an inlet and cable connector which is of the
23 locking type and weatherproof.

24 Use a winch assembly that is a self-locking worm gear type designed for operation with
25 a portable power unit. Have the winch drum automatically reverse the lay of the hoist
26 cable and prevent uneven build-up or tangling.

27 Provide a terminator for joining the hoist cable and 3 suspension or lifting cables.
28 Provide the means to compensate for variations in the lengths of the 3 lifting cables. Use
29 hoist and lifting cables made of stranded high strength stainless steel extra flexible
30 aircraft type. Use hoist and lifting cables that meet structural requirements of Military
31 Specification MIL-W-83420E and have the center strand not protruding more than 0.06"
32 after the cable is cut.

33 Use a power supply cable that is rated for suspension and has approved strain relief
34 fittings at each end. At the base of the standard, provide a locking type plug with
35 waterproof cover to connect to a short power supply cable stubbed from the circuit
36 breaker panel.

37 (C) Portable Drive

38 Supply a portable drive unit with a heavy duty reversible electric motor with torque
39 limiter type drive of adequate capacity, complete with a grounding type cord, suitable
40 couplings for attaching the unit to the winch assembly, and a sturdy storage container for
41 the unit and accessories involved. Provide one portable drive unit for the completed
42 project. Provide a drive unit with a lever switch controller with clearly marked up and
43 down positions. Connect the controller to the drive unit with a cord of sufficient length
44 to let the operator stand a minimum of 15 ft from the base of the high mount during
45 lowering or raising operations.

46 Shop assemble the portable drive unit and remove all rough edges. Use mounting or
47 adjustment bolts which allow hand tightening.

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1 Provide a complete unit that includes a durable metal storage case with all equipment and
2 instructions for operation. Use a case which is the approximate size as shown in the
3 plans, has a continuous hinge on the lid, and has sturdy carrying handles on each end.
4 Furnish a hasp with padlock as shown in the plans. Construct the case with 16 gauge
5 formed and welded steel with bracing to prevent warping. Paint the inside and outside
6 with a durable quality paint. Provide an identification label as noted in the plans on the
7 storage case.

8 (D) Circuitry

9 Install an enclosed circuit breaker in the base of the high mount standard. Use a breaker
10 which is rated 480 VAC, 2 pole, 30 A, and a minimum interrupting capacity of 14,000 A
11 unless noted otherwise in the plans.

12 Provide a supply cord originating from the circuit breaker with a female twist lock
13 connector for testing the luminaires at ground level, during lowering operation using the
14 portable drive unit and when in the raised position during normal night operation.

15 Provide a junction box mounted on the lowering ring with a flanged inlet to accept the
16 female twist lock connector from the supply cord. Use plugs, flanged inlets and
17 connectors for the supply cable and drive unit which allow grounding and are
18 weatherproof.

19 Install the wiring for each high mount luminaire separately from the luminaire to the
20 junction box. Series or loop circuitry is not allowed.

21 Provide a transformer, branch circuit breaker and GFCI receptacle as a power source for
22 the portable drive.

23 Provide an equipment grounding conductor in the supply cable. Include an equipment
24 grounding conductor in the wiring for each luminaire.

25 (E) Operation

26 Demonstrate the operation of the lowering device by raising and lowering the carrier ring
27 with luminaires a minimum of 5 times for each high mast. Include in this demonstration
28 latching and unlatching at the top and connection of test cables at the bottom. Twisting
29 of the cables, failure of the carrier ring to latch or unlatch, unlevelness of the carrier
30 hang-up of guide arms will be sufficient reason not to accept the lowering device.

31 1401-3 CONSTRUCTION METHODS

32 Use suitable blocking and slings to prevent warping of the high mount standard during storage
33 and transportation. Assemble all parts and string all cables in strict accordance with the
34 manufacturer's instructions.

35 Make sure that the top of the standard is not out of plumb more than 0.5% of its height.

36 Include assembly instructions and any special tools, blocks, washers, etc. in the portable drive
37 storage case.

38 Remove all dirt, stains, marks, etc. before erecting the high mast.

39 1401-4 MEASUREMENT AND PAYMENT

40 *High Mount Standards* with lowering devices to be paid will be the actual number of
41 standards installed and accepted. High mount lighting standards with lowering device,
42 measured as provided above, will be paid at the contract unit price each for ____ *High Mount*
43 *Standard* of the appropriate height.

44 *Portable Drive Units* with storage cases to be paid will be the actual number of portable drive
45 units furnished and accepted. Portable drive units with storage case, measured as provided
46 above, will be paid at the contract unit price each for Portable Drive Unit.

1 Payment will be made under:

Pay Item	Pay Unit
____ High Mount Standard	Each
Portable Drive Unit	Each

2

SECTION 1403

3

HIGH MOUNT LUMINAIRES

4 **1403-1 DESCRIPTION**

5 Furnish and install luminaires, including lamps and ballasts, for high mount standards 60 ft
6 and greater in height.

7 **1403-2 MATERIALS**

8 Provide luminaires consisting of a die cast aluminum ballast housing a cast aluminum
9 slipfitter housing, and cover which do not weigh more than 65 lb and have an effective
10 projected area not more than 2.5 sq.ft.

11 Provide ballast capable of operating a high pressure sodium lamp from a source with
12 a nominal voltage as shown in the plans with a tolerance of $\pm 10\%$. Provide luminaires with
13 IES Distribution, Cutoff, Type V and the wattage shown in the plans. The Department will
14 evaluate photometric data for submitted luminaire to ensure adequate light output from the
15 fixture.

16 Provide slipfitter housing suitable for use with 2" horizontal mounting, adjustable for leveling,
17 and which secures the mounting assembly to prevent twisting of the luminaire about the
18 bracket.

19 Use an optical assembly which contains a porcelain enclosed mogul socket with spring loaded
20 center contact . Position the socket for base up lamps.

21 Provide complete photometric, assembly and electrical data for each type luminaire proposed.
22 Include in the data candlepower distribution and isofootcandle graphs, assembly drawings
23 with replacement part numbers and electrical schematic with ballast input, output, voltage,
24 amperage and wattage ratings.

25 Provide same model lamps from same manufacturer for each respective luminaire type.

26 **1403-3 CONSTRUCTION METHODS**

27 Lamp all high mount fixtures just before testing the system.

28 Level and secure each luminaire in all directions. Careful attention should be given to aim the
29 main beams and house-side outputs of all asymmetrical units in the direction indicated in the
30 plans. Securely terminate the wiring for each luminaire and include an equipment grounding
31 conductor to bond the housing to the supply cord grounding conductor.

32 **1403-4 MEASUREMENT AND PAYMENT**

33 *High Mount Luminaires* ____ of the appropriate wattage and type will be measured and paid
34 as the actual number of luminaires of each size and type installed and accepted.

35 Payment will be made under:

Pay Item	Pay Unit
High Mount Luminaires ____	Each

Section 1404

SECTION 1404 LIGHT STANDARDS

1404-1 DESCRIPTION

Furnish and install light standards less than 55 ft high complete with bracket arm(s), including the impact attenuation device (breakaway base) as shown in the plans.

1404-2 MATERIALS

Provide a standard that meets the design criteria of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and the Interim Specifications valid at the time of letting. The support is to be designed for the wind velocity shown in the plans.

Provide a standard designed to support an ellipsoidal shaped luminaire, which has a center of gravity not more than 18" from the end of the support, with a minimum weight and projected area and a bracket arm length as indicated in the contract.

Make sure that each lighting standard has a grounding lug in the standard located within 6" of the handhole or in the transformer base.

Deliver standards with a smooth uniform finish, free of disfiguring scratches or dents and with suitable protection for further handling during erection.

Wrap or package each light standard as recommended by the manufacturer to prevent damage during shipping and handling. Repair or replace, at the option of the Engineer, any standards with abraded finishes or other damage.

Furnish aluminum or steel standards and arms; however, use the elected material throughout the project.

Galvanize steel components after fabrication. Use galvanization which conforms to the requirements of [ASTM A123](#) for tubes, plates and bars and to [ASTM A153](#) for hardware.

Use connecting bolts, washers and nuts compatible with the transformer base as recommended by the light standard manufacturer and which comply with the contract.

Use anchor bolts, washers, nuts and shims which comply with the Specifications and details shown in the plans as recommended by the light standard and transformer base manufacturer(s).

Furnish anchor and/or connecting bolt covers and pole top caps with standards as indicated in the plans.

Provide pole hardware such as nuts, bolts and washers for aluminum standards from 18-8 stainless steel or aluminum alloy 2024-T4. Provide nuts, bolts and washers for steel standards from 18-8 stainless steel or steel conforming to [ASTM A307](#). Submit drawings for approval which show material specifications for each component.

Use bracket arms for each standard which are the length shown in the plan sheet and of the same material as the standard.

Provide light standards with an approved impact attenuation feature (breakaway base) that complies with *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and one of the following descriptions:

- (A) A cast aluminum transformer base,
- (B) A frangible base insert or adapter, or
- (C) A slip base.

1 Use the same type of breakaway device throughout the entire project. All breakaway devices
 2 shall be FHWA approved. Include in the device protection for wiring and conduit at the base
 3 of the standard, in the form of a special heavy-formed material secured in place.

4 **1404-3 CONSTRUCTION METHODS**

5 Locate and number the light standards as shown in the plans.
 6 Do not lay the standards on the ground without proper blocking and protection to prevent
 7 warping and discoloration. Protect the standards from damage by other construction work,
 8 including landscape mulching and fertilizing operations.

9 Securely mount the standards on the anchor bolts, and plumb up with nuts torqued according
 10 to the manufacturer's recommendation.

11 Mounting height is defined as vertical distance from luminaire to surface of pavement of
 12 heaviest traveled lane in area illuminated by the luminaire. A tolerance of ± 1.5 ft from the
 13 required mounting height will be permitted. If this tolerance is exceeded, furnish and install
 14 an acceptable standard within this tolerance.

15 **1404-4 MEASUREMENT AND PAYMENT**

16 *Light Standards*, ____ will be measured and paid as the actual number of light standards with
 17 arm assemblies of each appropriate mounting height and bracket arm type and length installed
 18 and accepted.

19 Payment will be made under:

Pay Item	Pay Unit
Light Standards, ____	Each

20 **SECTION 1405**
 21 **STANDARD FOUNDATION**

22 **1405-1 DESCRIPTION**

23 Furnish and install all materials necessary to construct concrete foundations for light
 24 standards, including concrete, reinforcing steel, anchor bolts, nuts, forms, excavation and
 25 backfilling.

26 **1405-2 MATERIALS**

27 Refer to Division 10.

Item	Section
Conduit	1400-2(B)
Metal Shroud	1400-4(I)
Portland Cement Concrete, Class A	1000
Reinforcing Steel	1070

28 Provide Type 3 material certifications in accordance with Article 106-3 for conduit and
 29 anchor bolt assemblies. Store steel materials on blocking at least 12" above the ground and
 30 protect it at all times from damage; and when placing in the work make sure it is free from
 31 dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials. Load, transport,
 32 unload and store foundation and anchor bolt assembly materials so materials are kept clean
 33 and free of damage.

Section 1405

- 1 Provide anchor bolt assemblies in accordance with *Roadway Standard Drawings* No. 1405.01
2 consisting of the following:
- 3 (A) Straight anchor bolts or anchor bolts with hooks;
- 4 (B) Heavy hex nuts, leveling nuts, flat washers and lock washers on exposed ends of bolts;
5 and
- 6 (C) Nuts and flat bars on the other ends of straight anchor bolts embedded in concrete.
- 7 Use steel anchor bolts, nuts and flat washers that meet ASTM F1554 for Grade 55 bolts and
8 Grade A nuts. Provide steel lock washers. Galvanize anchor bolts and exposed nuts and
9 washers in accordance with Article 1076-4. It is not necessary to galvanize nuts and bars
10 embedded in concrete.

11 1405-3 CONSTRUCTION METHODS

12 The foundation design shown in the plans is based upon placing foundations into undisturbed
13 soil or fill of at least medium density. The Engineer will stake each location and determine
14 the top of foundation elevation unless indicated differently elsewhere in the Specifications.
15 The foundation type and depth will be determined by the plan details in accordance with the
16 final soil and slope conditions at each location. Set anchor bolts in accordance with stub
17 height requirements on the *Roadway Standard Drawings* No. 1405.01.

18 Pour the concrete for the pedestal portion monolithic with the barrier portion on light standard
19 foundations that are an integral part of a barrier. Construct the barrier portion as specified in
20 the contract and continuous through the foundation. Coordinate construction of foundations
21 in median barrier with the signing plans to avoid conflict with overhead sign structure
22 foundations.

23 Where rock creates a conflict with construction of the standard foundations, an alternate
24 foundation may be constructed if approved.

25 Install a ground rod adjacent to the light standard foundation and permanently attach
26 grounding conductor from standard.

27 1405-4 MEASUREMENT AND PAYMENT

28 *Standard Foundation* ____ will be measured and paid as the actual number of foundations for
29 each appropriate height and type of standard, completed and accepted.

30 The quantity of bedrock foundations to be paid will be the actual number of alternate
31 foundations for bedrock locations for standards of the appropriate type, installed and
32 accepted.

33 Alternate foundations for rock locations will be paid at 1.5 times the contract unit price each
34 for *Standard Foundations*, ____ of the appropriate type that would have been installed if rock
35 had not been encountered.

36 The requirements of Article 104-5, which pertain to adjustments in contract unit prices for
37 overrunning or underrunning pay items, will not be applicable to pay items covered by this
38 section.

39 Payment will be made under:

Pay Item

Standard Foundation, ____

Pay Unit

Each

SECTION 1406
LIGHT STANDARD LUMINAIRES

1406-1 DESCRIPTION

Furnish, install and place into satisfactory operation, luminaires on the bracket arm complete with all lamps, ballasts, wiring inside standard from circuit conductors to luminaire, in-line breakaway fuses and ground wiring at the pole on light standards less than 55 ft in height.

1406-2 MATERIALS

Use luminaires that are ellipsoidal shaped with a center of gravity not more than 18" from the end of the luminaire support, do not weigh more than 55 lb, and have a maximum effective projected area of 1.2 sq.ft.

Use luminaires that are UL listed and labeled.

Use luminaires that have a lens holder latch on the street side and ballast, plug-in starter and capacitors mounted on a removable door. The removable door shall have a continuous hinge bar to prevent door opening due to vibration. The luminaire shall have a slipfitter for 2 mounting brackets, with a stainless steel shield ring, a 4-bolt adjustable pipe clamp and leveling steps for tilt adjustment. Use luminaires with a replaceable mogul base lamp socket adjustable in both vertical and horizontal directions, capable of producing the specified IES distribution pattern. Third party certification for photometric data shall be provided upon request. Provide a heat resistant tempered flat glass lens and a reflector with a hard glasslike highly reflective corrosion resistant finish. Provide a filter between the lens and reflector tub.

Use luminaires that have an internal high power factor ballast of the regulated type, capable of operating from a multi-wire circuit and energize a high intensity discharge lamp. The luminaire shall have a barrier between the ballast compartment and the reflector tub. Transformer windings shall be covered and protected. Lamps shall operate satisfactorily with a line voltage variation of $\pm 10\%$. Provide a ballast pre-wired to the lamp socket and terminal board, requiring only the connection of the power supply leads to the terminal board.

Use luminaires with a wattage rating, voltage rating, lamp type and light distribution as indicated in the plans.

Provide same model lamps from same manufacturer for each respective luminaire type.

1406-3 CONSTRUCTION METHODS

Level luminaires using leveling pads on the luminaire enclosure. Adjust any luminaires, as directed, to give optimum illumination distribution.

1406-4 MEASUREMENT AND PAYMENT

Light Standard Luminaires ____ will be measured and paid as the actual number of luminaires of each appropriate size and style installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Light Standard Luminaires ____	Each

SECTION 1407
ELECTRIC SERVICE POLE AND LATERAL

1407-1 DESCRIPTION

Furnish and install wood service poles, wire, conduit, bushings, fittings, connectors, meter base and weatherhead from the service point to a control system.

Section 1408

1 **1407-2 MATERIALS**

2 Refer to Division 10.

Item	Section
Wood Poles, Class 4	1082
Type USE Wire	1091-2, 1400-2
Conduit	1091-3

3 **1407-3 CONSTRUCTION METHODS**

4 Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place
5 backfill in the hole in 6" maximum layers and thoroughly tamp. Place surplus earth around
6 the pole in a conical shape and pack tightly to drain water away.

7 Set the pole to a depth of at least 5.5 ft unless shown otherwise in the plans. When utility
8 power is available from outside the right of way, locate the service pole no more than 10 ft
9 inside the right of way. The utility company will install overhead conductors from their
10 facilities. Install an underground service lateral from the service pole to the control system.
11 The proposed service pole will be deleted from the contract if the utility company:

12 (A) Provides a pad mount transformer,

13 (B) Allows attachment of the riser and weatherhead to their pole, or

14 (C) Provides underground service from their pole.

15 Make connections at the service head at the bottom of the drip loop to prevent siphoning of
16 water through the cable.

17 Provide for a meter in accordance with the requirements of the utility company's condition of
18 service. A meter base for a self-contained meter may be mounted on the service pole or back
19 of the control enclosure as indicated in the plans. A current transformer (CT) cabinet and
20 meter base may be mounted in either location if requested by the utility company.

21 Use stranded copper Type USE conductors installed in rigid galvanized steel conduit sized as
22 shown in the plans for the service lateral.

23 **1407-4 MEASUREMENT AND PAYMENT**

24 *Electric Service Pole* ____ will be measured and paid as the actual number of the appropriate
25 length and class electric service poles installed and accepted.

26 *Electric Service Lateral* ____ from service pole to control panel will be measured and paid as
27 the actual number of linear feet of the appropriate size and type service lateral installed and
28 accepted. Measurement will be along the longest conductor from electrical terminal to
29 electrical terminal.

30 Payment will be made under:

Pay Item	Pay Unit
Electric Service Pole ____	Each
Electric Service Lateral ____	Linear Foot

31 **SECTION 1408**
32 **LIGHT CONTROL SYSTEM**

33 **1408-1 DESCRIPTION**

34 Furnish and install an entire control system, including enclosure, control panel, photocell,
35 switches, contactors, breakers, terminal blocks, wiring, concrete foundation and lightning
36 arrester. The control system will be standard electrical components in a stainless steel
37 enclosure mounted on a metal pole with a concrete foundation as shown in the contract.

1 **1408-2 MATERIALS**

2 Refer to Division 10.

Item	Section
Conduit	1091-3
Electrical Junction Box	1091-5
Portland Cement Concrete	1000-2
Wire and Cable	1091-2, 1400-2

3 Provide concrete foundations and wire in accordance with the Specifications.

4 Use a piece of 4" rigid galvanized steel conduit with threaded conduit cap, embedded in
5 concrete as shown in the plans for mounting the control system6 Provide a NEMA type 3R stainless steel enclosure with external stainless mounting flanges,
7 drip shield, back panel and continuous hinge door with a print pocket. Provide a door closing
8 mechanism interlocked with a flange mounted operator handle to prevent the opening of the
9 door with the service circuit breaker in the ON position, except by use of safety override
10 devices.11 Provide an enclosure approximately 36" (h) x 30" (w) x 10" (d) unless noted otherwise in the
12 plans. Provide only openings necessary for the entrance of conduits as shown in the plans.
13 Do not use knockouts. Ensure the enclosure conforms with NEC Article 312 and mount the
14 devices so the NEC clearances will be provided, except use 1.5" where not specified or noted
15 in the tables for minimum wire bending space.16 Use galvanized slotted steel framing channel with straps and bolts, sized as shown in the plans
17 for the mounting brackets and hardware for attaching the enclosure to the pole. Use
18 galvanized finish on the brackets and hardware and coat all field cuts or scratches with
19 organic zinc repair paint.20 Provide a polymer concrete (PC) electrical junction box measuring 36" (l) x 24" (w) x 18" (h)
21 (PC36) and meeting Section 1411.22 Provide a neutral bar bonded to the panel with sufficient box lug type terminals to accept the
23 required number of wires.24 Mount components to the back panel with manufacturer supplied mounting brackets or
25 permanently attached screw studs.26 Use a service circuit breaker providing an minimum interrupting rating of 22,000 A. Provide
27 thermal magnetic, molded case, permanent trip breakers. Provide multi-tap, solderless, load
28 side box lugs or distribution terminal blocks of the appropriate size. Use insulating material
29 approved for NEMA 3R applications. Provide a breaker with a voltage and amperage rating
30 as indicated in the plans.31 Provide a single pole, open type control circuit breaker rated at 240 VAC phase to ground
32 with a minimum current interrupting capacity of 5,000 A and a high magnetic trip setting
33 of 15 A.34 Provide three 60 A, 4 pole mechanically held contactors that have coil clearing contacts and
35 coil voltage rating as indicated in the plans. Contactor latching with hooks or
36 semi-permanent magnets is unacceptable.37 Use a control relay rated 240 VAC with one normally open contact and one normally closed
38 contact and has a continuous load rating and inductive make rating greater than that required
39 by the mechanically held contactor. Use a coil rated for 240 VAC, 60 Hz.40 Use a selector switch which is a heavy duty 3-position maintained contact unit in a surface
41 mount (NEMA 1) enclosure with a legend consisting of On-Off-Auto and having continuous
42 current rating of 10 A at 240 VAC for the contacts.

Section 1408

- 1 Use feeder circuit breakers which are rated 14,000 A minimum interrupting capacity and have
2 an open type molded case with a non-adjustable thermal magnetic trip setting as noted in the
3 plans.
- 4 Use a photo-control which is the encapsulated cadmium-sulfide type, suitable for use on
5 an operating voltage range of 105 V to 285 V and nominal control voltages of 120 V, 208 V,
6 240 V and 277 V. Ensure the control is rated for 1,000 W resistive load or 1,800 V-A of
7 inductive load. Set the light-level within a range of 1.0 to 3.0 footcandles. Have internal
8 protection for surges in excess of 2,000 V peak for the control. Mount a receptacle directly to
9 the top of the enclosure with a weatherproof fitting. Use controls and receptacles which
10 conform to NEMA Standard C136.10 for roadway lighting equipment.
- 11 Use a lightning arrester of the thyrite type, designed to contain and arrest an arc of 10,000 A.
12 Install the arrester on the load side of the service breaker.
- 13 Use terminals and lugs rated for the connection of the appropriate size copper conductors. All
14 conductors shall be made of copper and neatly wrapped in bundles or run in plastic raceways.
- 15 Perform all galvanizing in accordance with Section 1076.
- 16 Provide a drawing to scale showing the location, brand and catalog number of each
17 component of the control system for approval.
- 18 The completed light control system shall be marked "Suitable for Use as Service Equipment",
19 in a prominent location in the enclosure, in accordance with NEC Article 409.110. If the
20 control system is not made in a certified UL 60947-4-1A Panel Shop, a third party, recognized
21 by the Department of Insurance as having the authority, shall label the control systems.

22 **1408-3 CONSTRUCTION METHODS**

- 23 Construct the foundation for the control system as shown in the plans with the top of the
24 foundation 3" above finished grade.
- 25 Fasten the enclosure to the pole by means of a galvanized bracket assembly as shown in the
26 plans. Make all cuts square and remove all rough edges. Have mounting holes match
27 existing mounting holes of the enclosure.
- 28 Arrange all conduits entering the enclosure in a neat symmetrical manner and extend directly
29 downward into the foundation. Install all conduits shown in the plans. Stub and cap spare
30 conduits for future circuits underground.
- 31 Install the PC36 junction box within 2 ft of edge of pad in front of Control System. Stub all
32 feeder circuit conduits and spare conduits from Control System in this junction box. See
33 plans for conduit sizes. Place pull cord in any unused conduits and cap unused conduit in
34 junction box.
- 35 Apply 2 coats of organic zinc repair paint to all field cut metal and conduit threads as
36 specified in Article 1076-7.

37 **1408-4 MEASUREMENT AND PAYMENT**

- 38 *Light Control Equipment (Type)* will be measured and paid as the actual number of the
39 appropriate type light control systems completed and accepted.
- 40 Payment will be made under:

Pay Item	Pay Unit
Light Control Equipment, (Type) _____	Each

**SECTION 1409
ELECTRICAL DUCT**

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1409-1 DESCRIPTION

Furnish and install electrical duct including materials, equipment and labor for trenching, jacking, boring or directional boring and backfilling, so electrical circuits may be easily installed, repaired or replaced, and be protected from traffic loading at locations shown in the plans.

1409-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3

Use electrical duct that is non-metallic rigid PVC heavy wall conduit, HDPE Standard Dimension Ratio (SDR) 13.5 or rigid galvanized steel conduit.

1409-3 CONSTRUCTION METHODS

Duct is a passageway for electrical circuits. Install ducts in accordance with NEC requirements for an approved raceway. Locate the duct as shown in the plans and at a depth of at least 30" unless indicated otherwise in the plans. Locate bore pits outside the clear zone, as defined in the *AASHTO Roadside Design Guide*.

The lengths noted in the plans are only typical. Make actual field measurements to place the ends of the duct at the required locations. Make up lengths of duct with the minimum number of pieces joined together with couplings and solvent as recommended by the manufacturer.

Clean and plug the duct in accordance with Subarticle 1400-4(E).

Plug the duct with oakum or duct seal after feeder circuits in conduit are extended through duct.

Place buried duct in a trench with essentially vertical walls and only wide enough for easy installation of the duct. Tunneling by hand or other approved methods may be required to install duct beneath existing walks or paved ditches. Perform backfilling in accordance with Article 300-7.

Jacked duct may be installed by either of the following methods at the Contractor's option, when placement of electrical duct beneath pavement by jacking is noted in the plans.

(A) The duct may be pushed beneath the pavement through earth without prior construction of an opening.

(B) A bored opening not more than 1" larger than the outside diameter of the duct may be made by augering and the duct inserted.

(C) A drilled opening not more than 1" larger than the outside diameter of the duct may be made with a pneumatic vibrating machine and the duct inserted.

(D) HDPE conduit may be installed in accordance with Subarticle 1715-3(D).

Do not install non-metallic conduit by jacking method (A) as listed above.

If installation of a duct is begun and not completed, plug any opening as directed. Installation of duct by water jetting will not be acceptable.

At locations where it is indicated in the plans that the duct is to be connected to boxes, foundations, or other raceways, install in accordance with Subarticle 1400-4(E) to provide an approved raceway as specified by the NEC.

Section 1410

1 Unless otherwise noted in the plans, rigid galvanized steel conduit is intended for use in above
2 ground applications only.

3 **1409-4 MEASUREMENT AND PAYMENT**

4 *Electrical Duct (Size and Type)* will be measured and paid as the actual number of linear feet
5 of duct, measured in place to the nearest whole foot, installed and accepted.

6 Payment will be made under:

Pay Item	Pay Unit
Electrical Duct, (Size & Type) _____	Linear Foot

7 **SECTION 1410**
8 **FEEDER CIRCUITS**

9 **1410-1 DESCRIPTION**

10 Furnish and install all conductors and conduit, including tools, equipment, trenching and
11 backfilling to provide electrical circuits at locations shown in the plans.

12 **1410-2 MATERIALS**

13 Refer to Division 10.

Item	Section
Conduit	1091-3
Wire and Cable	1091-2, 1400-2

14 Use UL listed, Type USE wire for feeder circuits in conduit. The equipment grounding
15 conductor may be bare or insulated. Use conductors which are copper and in accordance with
16 Subarticle 1400-2(C). Give careful attention to the required color code. Do not mark a white
17 conductor in a cable assembly any other color; however, a white conductor may be stripped at
18 all accessible points and used as a bare equipment grounding conductor.

19 Provide metallic (rigid galvanized steel) and non-metallic (PVC or HDPE) conduit in
20 accordance with the Subarticle 1400-2(B) with the appropriate type being used at locations as
21 shown in the plans.

22 **1410-3 CONSTRUCTION METHODS**

23 Install feeder circuits in continuous runs, without splices, except at junction boxes or within
24 light standard bases.

25 Install conductors in accordance with the Subarticle 1400-4(F) and conduit in accordance with
26 the Subarticle 1400-4(E).

27 Excavate trenches to depths and widths as shown in the plans with essentially vertical walls
28 and as straight as possible, when underground feeder circuits are required. Locate
29 underground feeder circuits a minimum of 6 ft back of the face of curb or outside the limits of
30 the paved shoulder and stone base, as directed. Use care to prevent conflict with existing or
31 future guardrails, sign posts, delineators and similar devices.

32 Surround the underground feeder circuit in conduit with clean soil and use backfill free of
33 rocks and other objectionable materials which might damage the conduit. This will require
34 partial backfilling by hand in areas where it is likely that objectionable materials will be
35 included if mechanical methods of backfilling are used.

36 Perform all necessary search methods, including, but not limited to, use of underground metal
37 detection equipment and excavation equipment, to locate existing electrical duct. Locate the
38 duct and perform all necessary work including cleaning of the duct before installation of
39 proposed circuits.

1 When a feeder circuit in conduit passes through electrical duct, make the conduit continuous
 2 through the duct unless specifically noted otherwise in the plans. After feeder circuits in
 3 conduit are extended through duct, plug the duct with oakum or duct seal.

4 When only feeder circuits are required, install the load current carrying conductors and
 5 grounding conductors in either existing conduit or conduit installed under other contract
 6 items.

7 When more than one circuit is installed in a single raceway, a single equipment grounding
 8 conductor sized as required for the largest circuit may be used without change in the contract
 9 unit bid prices.

10 Multiple circuits may be placed in the same trench if they are grouped and separated
 11 a minimum distance of 3". When more than one circuit is installed in the same trench there
 12 will not be any adjustment of the contract unit bid prices.

13 **1410-4 MEASUREMENT AND PAYMENT**

14 *Feeder Circuits* will be measured and paid as the actual number of linear feet of each
 15 size and type feeder circuit completed and accepted. Measurement will be to the nearest
 16 whole foot from electrical terminal to electrical terminal of the longest load current carrying
 17 conductor.

18 *Feeder Circuit in* *Conduit* will be measured and paid as the actual number of linear feet
 19 of each size and type feeder circuit completed and accepted. Measurement will be to the
 20 nearest whole foot from electrical terminal to electrical terminal of the longest load current
 21 carrying conductor.

22 Payment will be made under:

Pay Item	Pay Unit
<u> </u> Feeder Circuit	Linear Foot
<u> </u> Feeder Circuit in <u> </u> Conduit	Linear Foot

23 **SECTION 1411** 24 **ELECTRICAL JUNCTION BOXES**

25 **1411-1 DESCRIPTION**

26 Provide junction boxes made from fiberglass reinforced polymer concrete and cast-metal
 27 boxes encased in concrete of the appropriate type at locations noted in the plans, complete
 28 with all necessary covers, conduits, duct and hardware, in accordance with the contract.

29 **1411-2 MATERIALS**

30 Refer to Division 10.

Item	Section
Backfill	545, 1005
Electrical Junction Boxes	1091-5

31 Provide a polymer concrete junction box which is open bottom with a foot. Provide
 32 a standard "Electric" logo on the cover unless specifically noted otherwise in the plans.
 33 Backfill beneath and around the boxes using ABC in conformance with Section 1005.

34 **1411-3 CONSTRUCTION METHODS**

35 Install conduits and duct before the polymer concrete (PC) boxes are set in place. Do not rest
 36 the bottom of the box directly on conduits, ducts or cables.

Section 1412

1 Place the top of the box on the same grade as the surrounding area. Perform backfilling with
2 sufficient care that no part of the junction box, conduit or duct is displaced or moved out of
3 alignment. Backfill beneath and around the box to at least 12" using #67 washed stone
4 aggregates in conformance with Section 545 and Section 1005.

5 Locate junction boxes for best routing of conduit and duct and to minimize drainage
6 problems. Do not locate boxes in useable shoulders or pavements or other areas where they
7 may be subjected to traffic loadings.

8 Stub the ends of conduit and duct up vertical as near the top of the box as practical and seal.
9 Arrange wiring so that it will not lay in the bottom of the box.

10 Install cast-metal (BR) boxes and arrange conduits and ducts to best fit field conditions.
11 During the construction of the median barrier reinforcement, accurately space and securely
12 attach Type BR junction boxes and conduits inside the reinforcement. Bond junction box to
13 the reinforcement in accordance with NEC Article 250.52. Place boxes with covers flush
14 with surface of concrete (generally traffic side of median barrier).

15 Place mastic between the cast metal box frame and the cast concrete barrier, as shown on
16 plans to allow easy replacement of the frame.

17 **1411-4 MEASUREMENT AND PAYMENT**

18 *Electrical Junction Boxes* ____ will be measured and paid as the actual number of the
19 appropriate type and size junction boxes installed and accepted. Payment for the conduit,
20 duct and wiring will be paid under other contract items. Items used for splicing are incidental
21 to the junction boxes.

22 Payment will be made under:

Pay Item	Pay Unit
Electrical Junction Boxes ____	Each

23 **SECTION 1412**
24 **UNDERPASS LIGHTING**

25 **1412-1 DESCRIPTION**

26 Furnish and install wall mounted and/or pendant mounted luminaires with electrical circuitry,
27 for underpass lighting at locations shown in the plans. Work includes, but is not limited to,
28 furnishing and installing underpass luminaires with lamp, ballast and mounting hardware as
29 well as furnishing and installing circuit breakers and enclosure, pull boxes, conduit,
30 conductors, expansion fittings, anchors, straps and ground rod.

31 **1412-2 MATERIALS**

32 Refer to Division 10.

Item	Section
Conduit	1091-3
Wire and Cable	1091-2

33 Use luminaires that are listed as "Suitable for Wet Locations" according to UL Standard 1572,
34 with sealed and filtered optical assemblies. Use high power factor ballasts that are completely
35 pre-wired integral units, for reliable starting and operating of high pressure sodium lamps
36 at -40°F ambient temperature. Use heavy-duty mogul base lamp sockets, with split shell
37 tempered brass lamp grips and a free-floating, spring-loaded center contact. Use the
38 luminaire type, wattage, voltage and IES illumination distribution pattern as shown in the
39 plans.

1 Provide Type WM luminaires that are wall mounted, with cast aluminum housing painted
 2 with premium quality gray or dark bronze paint. Provide a prewired ballast and terminal
 3 board assembly and cast aluminum side-hinged door with glass refractor. Use the same color
 4 Type WM luminaires throughout the project. Provide factory installed mounting holes in the
 5 back and conduit entrances in the sides and top. Provide a formed aluminum reflector and
 6 socket assembly, with a chemically-bonded, lightweight, non-breakable glass finish, which is
 7 removable with only a screwdriver.

8 Provide Type PM luminaires that are a pendant mounted assembly of ballast, optical and
 9 mounting components, including a safety chain and hanging hardware. Provide a die-cast
 10 aluminum ballast housing with gray paint finish, with a prewired ballast assembly and
 11 an external quick electrical disconnect receptacle for attachment of hanging hardware.
 12 Provide a faceted aluminum reflector with a hard glasslike highly reflective corrosion
 13 resistant finish and a lightly diffused refractor made of UV stabilized, injection molded,
 14 prismatic, heat-resistant acrylic. Provide hinges and stainless steel, over-center, vibration-
 15 resistant spring latches for easy access to the lamp and clamping of the gasket between the
 16 refractor and ballast housing.

17 Use a 3/4" rigid galvanized steel conduit with a hook and power cord entrance as the pendant.
 18 Provide a 3-conductor Type SO power cord and a 3/4" female threaded wiring compartment
 19 with quick electrical disconnects, to attach the ballast housing to the pendant as shown in the
 20 plans.

21 Use galvanized weldless forged steel eye-nuts that comply with Federal
 22 Specification WW-H-171E (Type 17), or Manufacturers Standardization Society SP-69-2003
 23 (Type 17). Attach eye nuts to galvanized steel or stainless steel threaded rod anchored to the
 24 bridge deck with adhesive anchors. Use galvanized steel or stainless steel safety chain,
 25 S-hooks and lock nuts.

26 Use conduit and wire in accordance with Article 1400-2 and gasketed PVC junction boxes as
 27 shown in the plans.

28 Use a 2-pole, 480 VAC, 20 A circuit breaker with an interrupting capacity of at least
 29 14,000 A, installed in a NEMA 3R enclosure. The enclosure should be primed and painted
 30 with a premium grade exterior paint before installation to increase corrosion resistance.
 31 Install an equipment ground bar and provide a lock in accordance with Article 1400-8.

32 **1412-3 CONSTRUCTION METHODS**

33 Mount luminaires as shown in the plans. Use galvanized steel or stainless steel clamps and
 34 attachment hardware.

35 Install circuitry in accordance with Article 1400-4.

36 **1412-4 MEASUREMENT AND PAYMENT**

37 *Underpass Luminaires* ____ will be measured and paid as the actual number installed and
 38 accepted.

39 *Underpass Circuitry at* ____ will be paid at the contract lump sum price for underpass
 40 circuitry at the appropriate location.

41 Payment will be made under:

Pay Item	Pay Unit
Underpass Luminaires ____	Each
Underpass Circuitry at ____	Lump Sum

Section 1413

**SECTION 1413
PORTABLE CONSTRUCTION LIGHTING**

1413-1 DESCRIPTION

Furnish, operate and maintain everything necessary to provide lighting for compliance with Article 105-14 Night Work requirement for artificial lighting.

1413-2 MATERIALS

Furnish all lighting equipment as required and retain after the work is completed. Material and/or equipment is not required to be new but shall be in good operating condition and in compliance with applicable safety and design codes.

Submit, for the review and approval catalog cuts giving the specific brand names, model numbers and ratings of the lighting equipment. Include in the submittals power ratings and photometric data. Allow 40 days for review of the submittals. Do not begin night work without approval of the equipment and/or materials.

1413-3 TOWER LIGHT

Use tower lights which consist of mercury vapor, metal halide, high pressure sodium or low pressure sodium fixtures mounted on a tower approximately 30 ft in height. Use tower light fixtures which are heavy duty flood, area, or roadway style with wide beam spread, have an output of 50,000 lumens minimum, have the combined outputs of all fixtures on each tower light not exceed 460,000 lumens, and are weatherproof and supplied with attached waterproof power cord and plug. Use a sturdy tower which is freestanding without the aid of guy wires or bracing. Provide sufficient capacity in the power supply to operate the light(s) and locate it for the shortest safe routing of cables to the fixtures. A tower light consisting of the combined fixture(s), tower and power supply is preferred.

Provide tower lights of sufficient wattage and/or quantity to provide an average maintained horizontal illuminance greater than 20 footcandles over the work area.

Aim and position the lights to illuminate the area for construction work. Make sure that there is not any disabling glare to the motorist. In no case should the main beam of the light be aimed higher than 60° above straight down. The lights should be set as far from traffic as practical and aimed in the direction of, or normal to, the traffic flow.

1413-4 MACHINE LIGHTS

Use machine lights which have mercury vapor, metal halide, high pressure sodium or low pressure sodium conventional roadway enclosed fixtures mounted on supports attached to the construction machine at a height of approximately 13 ft. Use fixtures for machine lights which have light output between 22,000 and 50,000 lumens. Use a power supply with sufficient capacity to operate the light(s) and securely mount on the machine. Perform electrical grounding of generators to frames of machines on which they are mounted in conformance with the NEC.

Use machine light fixtures with sufficient wattage and/or quantity to provide an average maintained horizontal illuminance greater than 10 footcandles on the machine and the surrounding work area. Machine lights are in addition to conventional automotive type headlights which are necessary for maneuverability.

Balloon lights are an acceptable alternate luminaire for machine lights.

1413-5 CONSTRUCTION METHODS

Use tower lights when the night work is confined to a fairly small area and is essentially a stationary operation. Space tower lights no closer than 100 ft apart and no further than 300 ft apart. Actual spacing will be determined by approved equipment. At any spacing, the required 20 footcandles of light will be the determining factor.

Section 1413

1 Use machine lights when the night work is not confined to a small area and is essentially
2 a continuous moving construction operation.

3 Tower lights may be provided instead of machine lights upon approval by the Engineer. Use
4 of tower lights instead of machine lights will be considered when the number of machines,
5 type of work, or need for inspection justify their use as decided by the Engineer.

6 Illuminate the work area where traffic control devices are being set up or repositioned at
7 night.

8 The work areas to be illuminated are the areas where construction equipment and labor are in
9 operation and may be different from the work areas shown in the plans.

10 Illuminate a large enough work area so that the movements of all personnel and equipment
11 engaged in the work will be contained in the area.

12 Provide sufficient fuel, spare lamps, generators and personnel qualified to operate the lights to
13 assure that they will be maintained in operation during night work.

14 Existing streetlights do not eliminate the requirement for the Contractor to provide lighting.
15 Consideration may be given to the amount of illumination provided by existing lights in
16 determining the wattage and/or quantity of lights to be provided.

17 **1413-6 MEASUREMENT AND PAYMENT**

18 *Portable Lighting* provided by tower and machine lights will be paid only when a significant
19 amount of nighttime work is explicitly required and a pay item for portable lighting has been
20 included in the contract. Otherwise, portable construction lighting will be incidental to other
21 contract items and no direct payment will be made.

22 The aggregate amount to be paid on each partial payment estimate will be equal to the
23 percentage that the item of *Portable Lighting* is complete as estimated by the Engineer.

24 Payment will be made under:

Pay Item	Pay Unit
Portable Lighting	Lump Sum

DIVISION 15

UTILITY CONSTRUCTION

SECTION 1500

GENERAL UTILITY REQUIREMENTS

1500-1 DESCRIPTION

Construct various utilities as required by the contract or as directed.

Apply the applicable provisions of the rules and regulations of the NCDENR, Division of Environmental Health to the construction of water lines. Apply the rules and regulations of NCDENR's Division of Water Quality to the construction of sanitary sewer lines. Perform all work in accordance with the applicable plumbing codes.

1500-2 COOPERATION WITH THE UTILITY OWNER

The utility owner owns the existing utility facilities and will own the new utility facilities after acceptance by the Department. The Department owns the construction contract and has administrative authority. Communications and decisions between the contractor and utility owner are not binding upon the Department or this contract unless authorized by the Engineer. Agreements between the utility owner and contractor for work that is not part of this contract or is secondary to this contract are allowed, but are not binding upon the Department.

Provide access for Department personnel and the owner's representatives to all phases of construction. Notify Department personnel and the utility owner 2 weeks before commencement of any work and one week before service interruption. Keep utility owners' representatives informed of work progress and provide opportunity for inspection of construction and testing.

Except in an emergency, do not operate any of the controls on the existing systems without prior approval of the owner.

Notify the utility owner at least 24 hours in advance of all arrangements for temporary service and for agreement with the owner as to the time that service may be interrupted.

1500-3 UTILITY LOCATIONS AND CONTRACTOR'S RESPONSIBILITY

The plans depict the best available information for the location, size and type of material for all existing utilities. Make investigations for determining the exact location, size and type of material of the existing facilities as necessary for the construction of the proposed utilities and for avoiding damage to existing facilities. Repair any contractor caused damage of existing facilities to the original or better condition at no additional cost to the Department.

1500-4 WEEKEND, NIGHT AND HOLIDAY WORK

Make connections between existing and proposed utilities at times most convenient to the public, without endangering the utility service and in accordance with the utility owner's requirements. Make connections on weekends, at night and on holidays, if necessary.

1500-5 RELATION OF WATER MAINS TO SEWERS

Lay water mains at least 10 ft laterally from existing or proposed sewers. If local conditions or barriers prevent a 10 ft separation, lay the water main with at least 18" vertical separation above the top of the sewer pipe either in a separate trench or in the same trench on a bench of undisturbed earth.

Section 1500

1 When a proposed water main crosses over a proposed or existing sewer, lay the water main
2 with at least 18" vertical separation above the top of the sewer. If local conditions or barriers
3 prevent an 18" vertical separation, construct both the water main and the sewer for a distance
4 of 10 ft on each side of the point crossing with ferrous pipe having water main quality joints.

5 When a proposed water main crosses under a proposed or existing sewer, construct both the
6 water main and the sewer of ferrous materials with joints that are equivalent to water main
7 standards for a distance of 10 ft on each side of the point of crossing. Center the section of
8 water pipe at the point of crossing.

9 **1500-6 PROTECTION OF PEDESTRIAN AND VEHICULAR TRAFFIC**

10 During the progress of the work, keep sidewalks and crossings open for the passage of
11 pedestrians. Take necessary measures to keep roadways open for traffic unless lane or
12 roadway closures are approved.

13 Construct and maintain adequate and approved bridges over excavations as necessary for the
14 purpose of accommodating pedestrians or vehicles.

15 When open cut installation is allowed across a roadway and traffic is to be maintained,
16 construct the installation in sections so that half the width of the roadway will be available to
17 traffic. Provide all traffic control measures necessary to provide for safe traffic passage.

18 **1500-7 SUBMITTALS AND RECORDS**

19 Deliver only approved materials to the project. Provide sufficient information as required
20 under Sections 105 and 106 to demonstrate the materials meet the specifications and intended
21 use. Provide 2 copies to the utility owner and 6 copies to the Engineer. Identify each item's
22 intended use. As a minimum, the submitted information shall show the material description,
23 brand name, stock number, size, rating and manufacturing specification.

24 Provide working drawings of thrust restraint designs and connection details along with
25 schedules for performing the work.

26 Provide as-built plans of the installed utility. The plans shall include notations of the size and
27 type material installed, coordinates of utility controls and horizontal and vertical locations of
28 the piping. Provide 2 copies to the utility owner and 2 copies to the Engineer.

29 **1500-8 LOCATING AND MARKING**

30 Tape a continuous locator wire along the top of all piping. Mechanically fasten locator wire
31 to valve boxes, meter boxes, fire hydrants, manhole covers and other above grade
32 appurtenances. Install marking tape 18" to 24" below finished grade above all pipelines.

33 **1500-9 PLACING PIPELINES INTO SERVICE**

34 Make final connections of the new work to the existing mains where indicated in the plans, as
35 required to fit the actual conditions or as directed. Provide sufficient work crews, equipment
36 and materials on site to assure quick and efficient connections.

37 Schedule and notify owners and customers in advance of any interruptions of water service
38 with ample time to make arrangements. Limit interruption of service to water customers to no
39 more than 8 hours. Provide temporary connections as needed to maintain service.

40 **1500-10 MEASUREMENT AND PAYMENT**

41 The general utility construction work will be incidental and will be paid at the contract unit
42 prices of the various utility items included in the contract.

SECTION 1505
EXCAVATION, TRENCHING, PIPE LAYING
AND BACKFILLING FOR UTILITIES

1505-1 DESCRIPTION

Perform all excavation, undercut, foundation conditioning, pipe laying, bedding, backfill and pavement, sidewalk and driveway repair necessary for installation of utilities.

1505-2 MATERIALS

Refer to Division 10.

Item	Section
Portland Cement Concrete, Class B	1000
Select Material	1016

Use Class III, IV, V or VI select material for foundation conditioning and bedding.

1505-3 CONSTRUCTION METHODS

Excavate, trench, lay pipe, bed and backfill utilities in conformance with the applicable requirements of Division 1, Division 2 and Articles 300-1, 300-4 and 300-6. Comply with AWWA and ASTM standards along with the product manufacturer requirements for installing utilities.

(A) Shoring

Excavate trenches and pits for the installation of utilities that are safe for the workers and roadway users and that protect the roadway and other property from damage. Provide appropriate groundwater and surface water controls to stabilize the excavation and foundation and to provide a clean working area.

(1) Worker Safety

Provide any necessary shielding or shoring to protect workers.

(2) Roadway Users

Provide shielding or shoring as required under Sections 150 or as required elsewhere in the contract.

(3) Roadbed and Foundation Protection

Provide shoring of excavations less than one horizontal to one vertical from existing or proposed pavement to prevent failure or weakening of the roadbed. Provide plans and designs demonstrating the methods and techniques proposed and their adequacy. Provide engineered shoring systems as required for the actual conditions.

(B) Foundation Conditioning

Undercut and replace weak or saturated soils below the pipe trench with select material to provide a firm foundation.

(C) Bedding

Provide excavations with sufficient width for placing and compacting bedding around the utility. Bed utilities in select material. Place bedding material to stable ground on both sides and to at least 2" below and above the pipe bells. Provide at least 6" of bedding material between rock and piping. Shape the bottom of trenches to fit the pipe. Compact bedding material completely in the pipe haunches. Provide recesses in the bedding to accommodate pipe joints.

Section 1505

1 (D) Pipe Laying

2 Lay pipe in accordance with the specifications and the manufacturer's recommendations.
3 Except where necessary in making connections with other lines or as authorized by the
4 Engineer, lay pressurized pipe with the bells facing in the direction of laying.

5 Where possible, keep joints exposed for visual inspection during testing.

6 During the progress of the work and until the completion and final acceptance, keep the
7 pipelines and their appurtenances clean throughout and remove any obstructions or
8 deposits. Provide secure watertight seals on pipe when work is not in progress.

9 Lay gravity sewer pipe upgrade with the spigot ends pointing in the direction of flow.
10 Lay each pipe to form a close concentric joint with the adjoining pipe and to prevent
11 sudden offsets of the flow line.

12 (E) Thrust Restraint

13 Provide thrust restraint for pressurized pipelines and appurtenances. When shown in the
14 plans, construct as specified with modifications to match the actual field conditions.
15 When not shown, engineer the thrust restraint system with a factor of safety of 1.25 for
16 the test pressure specified and for the actual field conditions.

17 Provide thrust restraint on the existing piping system as necessary.

18 Use joint restraint methods, such as integral restraining bells and spigots, restraining
19 retainer glands, restraining gaskets or restraining clamps and lugs with tie rods. Use
20 concrete reaction backing and thrust collars where joint restraint is impractical.

21 Where any section of a main is provided with concrete thrust restraint for fittings,
22 controls or hydrants, perform the hydrostatic pressure test after the concrete reaches
23 appropriate strength.

24 (F) Backfilling

25 Backfill in accordance with Article 300-7 and compact to the density required by
26 Subarticle 235-4(C).

27 1505-4 REPAIR OF PAVEMENTS, SIDEWALKS AND DRIVEWAYS

28 Repair sidewalks and driveways that are disturbed by excavation and trenching to an original
29 or better condition in accordance with Section 848.

30 Use asphalt plant mix to repair or replace pavement damaged by utility work. Perform all
31 work in accordance with Section 654. Immediately upon completion of the utility removal or
32 installation, make repairs to the pavement.

33 1505-5 CONCRETE ENCASEMENT OF UTILITY LINES

34 Encase existing or proposed utility lines in concrete for protection in areas as shown on the
35 utility plans or as directed. Place the concrete completely around the line with a minimum
36 thickness of 6".

37 1505-6 MEASUREMENT AND PAYMENT

38 *Foundation Conditioning* material will be measured and paid as provided in Section 300.

39 *Asphalt Plant Mix* for pavement repair will be measured and paid as provided in Section 654.

40 *Class B Concrete for Encasing Utility Lines* will be measured and paid in cubic yards of
41 concrete, measured in place.

42 ___" *Concrete Sidewalk* and ___" *Concrete Driveways* will be measured and paid in accordance
43 with Article 848-4.

1 Trenching, excavation, pipe laying, bedding, backfilling and disposal of unsuitable materials
 2 for utility construction are included in the contract price for the applicable utility item and no
 3 separate measurement or payment will be made.

4 The following work and items are included in the contract price for the applicable utility item
 5 and no separate measurement or payment will be made for items (A) through (F) below:

- 6 (A) Undercut or Wet Excavation,
- 7 (B) Dewatering of Excavation,
- 8 (C) Shoring and Sheet piling (except temporary shoring for maintenance of traffic covered
 9 elsewhere in the contract),
- 10 (D) Thrust Restraint,
- 11 (E) Bedding Material, or
- 12 (F) Select Material for Backfill.

13 Payment will be made under:

Pay Item	Pay Unit
Class B Concrete for Encasing Utility Lines	Cubic Yard

14 **SECTION 1510**
 15 **WATER LINES**

16 **1510-1 DESCRIPTION**

17 Provide water lines suitable for use in transporting potable water.

18 **1510-2 MATERIALS**

19 Refer to Division 10.

Item	Section
Water Pipe and Fittings	1036

20 The Contractor may use any of the water pipe specified under Section 1036 except where
 21 a particular type pipe is specified in the plans or required by environmental regulations or
 22 Departmental policy. The Contractor shall verify that the pipe is appropriate for the test
 23 pressure of the system and the external loading.

24 Use ductile iron fittings on water lines 4" or larger.

25 Use #12 AWG solid-copper wire with blue insulation for the utility locator wires.

26 Use 2" plastic marking tape colored blue with "Caution Water Line" or similar wording,
 27 permanently printed at 36" centers.

28 Protect steel rods and other metal clamps and lugs by galvanizing or painting with approved
 29 bituminous paint.

30 **1510-3 CONSTRUCTION METHODS**

31 **(A) General**

32 Meet the installation standards of AWWA or ASTM for water line construction.

33 Apply Section 1505 for excavation, trenching, pipe laying and backfill to water line
 34 installation.

35 Install small diameter pipe (4" or less) under existing pavement by a trenchless method at
 36 no additional cost to the Department.

Section 1510

1 Connect the ends of the water service piping using AWWA C800 type couplings or
2 fittings. Make NPT screw joints with a double wrap of a polytetrafluoroethylene (PTFE)
3 tape and torque as required by the manufacturer.

4 Store plastic pipe out of direct sunlight until burying. All plastic pipe showing
5 discoloration or deterioration will be rejected for use and replaced with suitable pipe as
6 specified under Article 106-9.

7 Install water lines with 36" to 42" of cover to finished grade unless otherwise directed or
8 approved. Install water lines with greater cover for short distances to accommodate
9 utility controls, to make tie-ins to existing facilities, to eliminate high points in the
10 pipeline or to provide clearance between existing and proposed utilities, drainage, other
11 obstacles or actual field conditions.

12 (B) Testing and Sterilization

13 Perform pressure and leakage tests and sterilization on newly installed water mains and
14 altered water mains prior to placing such pipelines into service. Provide all equipment,
15 piping, controls, pumps, water and safety devices necessary for performing the tests and
16 sterilization.

17 Obtain clean water for cleaning, testing and sterilization from approved sources. Provide
18 connections to potable water sources with approved backflow preventors until acceptance
19 of all test results.

20 Perform tests using clean water and provide certified results demonstrating leakage less
21 than the following amount when pressurized at 200 ± 5 psi for 2 hours.

$$W = LD(\sqrt{P}) \div 133,200$$

Where:

- W** = allowable leakage in gallons per hour
- L** = length of pipeline tested, in feet
- D** = nominal diameter of the pipe, in inches
- P** = average test pressure during the leakage test, in lb/sq.in.

22 Repair using approved methods or replace pipe, controls or appurtenances as necessary to
23 reduce leakage below acceptable levels. Additionally, repair any leaks that are visible
24 after 2 hours duration.

25 Clean water lines by flushing with water at least 2.5 ft/s velocity. Remove all debris and
26 dirt from water mains larger than 4" by passing a medium density foam pig with abrasive
27 strips through the lines.

28 Sterilize water lines according to NCDENR requirements and AWWA C651. Provide
29 certified bacteriological and contaminant test results from an approved independent
30 testing laboratory in accordance with NCDENR requirements. Operate all valves and
31 controls to assure thorough sterilization.

32 Testing, cleaning and sterilization may be performed concurrently or consecutively.

33 Dispose of waste water in accordance with all environmental regulations.

34 For short sections (less than 100 ft) and tie-in sections of water lines perform visual tests
35 for leakage after installation instead of separate pressure and leakage tests. Sterilize
36 according to AWWA C651 Sections 4.6 and 4.7.

37 Provide copies of the test results to the Engineer and to the water line owner.

38 Flush with clean water until the residual chlorine is reduced to the same level as in the
39 existing water mains.

1 Place new water lines into service after approval of all testing and flushing and
 2 authorization by the Engineer.

3 **1510-4 MEASUREMENT AND PAYMENT**

4 Water lines of the various sizes will be measured from end to end in place with no deduction
 5 for length through valves or other fixtures and paid by the horizontal linear foot. Water lines
 6 smaller than 2" and branch lines or service lines to fire hydrants, water meters and backflow
 7 prevention assembly will not be measured or paid.

8 If the contract does not include such pay items, measurement will not be made and the work
 9 will be incidental to other contract pay items.

10 Payment will be made under:

Pay Item	Pay Unit
___" Water Line	Linear Foot

11 **SECTION 1515**
 12 **UTILITY CONTROLS**

13 **1515-1 DESCRIPTION**

14 Provide appropriate control devices, valves, meters, backflow prevention assembly and
 15 hydrants on water lines and force main sewers.

16 **1515-2 MATERIALS**

17 Refer to Division 10.

Item	Section
Sanitary Sewer	1034
Water	1036

18 Deliver only approved materials to the project.

19 Air release valves shall meet AWWA C512. In addition, air release valves for sanitary sewer
 20 force mains shall have long bodies, shall be equipped with back flushing connections and
 21 shall have a hood over the outlet.

22 Double check valves (DCV) backflow prevention assembly shall meet AWWA C510.
 23 Reduced pressure principle (RPZ) backflow prevention assembly shall meet AWWA C511.

24 Line stops consist of a sleeve, temporary valve and closure cap. The sleeve and cap shall
 25 meet applicable AWWA standards, shall be made of cast iron or stainless steel, shall be
 26 pressure rated at 200 psi and shall be sized for the type pipe to be tapped. The temporary
 27 valve shall be suitable for contact with potable water with NSF certification and designed to
 28 match the actual field conditions.

29 Line stop bypass pipe shall be pressure rated at 200 psi, shall be NSF certified and shall be
 30 adequately restrained.

31 Use screw or slip type valve boxes with a base to fit the valve yoke and a removable plug cap
 32 with the word "Water" or "Sewer" cast therein.

33 Precast manholes in accordance with Section 1525.

34 **1515-3 CONSTRUCTION METHODS**

35 Apply Section 1505 for excavation, trenching, pipe laying and backfill.

36 Place two 4" x 8" x 16" concrete blocks beneath valves and fire hydrants for support.

Section 1515

- 1 When necessary, due to project staging, install valves, meters and fire hydrants as appropriate
2 for the current grade and make adjustments to finished grade as work progresses.
- 3 Provide enclosures with positive drainage for utility controls.
- 4 **(A) Valves**
- 5 Install all valves with an approved valve box set flush with the ground or pavement.
6 Place a 24" diameter precast concrete ring flush with the ground around all valve boxes
7 not in pavement.
- 8 Test and sterilize tapping valves before making the tap. Do not allow cuttings to enter
9 the tapped main.
- 10 **(B) Meters**
- 11 Install water meters adjacent to the right of way or as shown in the plans.
12 Place meter boxes with the top of the meter box flush with finished grade of the project.
- 13 **(C) Backflow Prevention Assembly**
- 14 Install backflow prevention assembly off the highway right of way or as shown in the
15 plans.
- 16 Licensed installers shall test and certify RPZ backflow preventor installations. Enclose
17 RPZ backflow prevention assembly above grade in a hot box.
- 18 Enclose DCV backflow prevention assembly below grade in a precast concrete vault with
19 positive drainage or above grade in a hot box.
- 20 Install the hot box on a 4" thick concrete slab that is 6" larger than the box and 2" to 4"
21 above finished grade.
- 22 **(D) Fire Hydrants**
- 23 Install fire hydrants outside of the vehicle recovery area of the roadway, adjacent to the
24 right-of-way line or in protected areas.
- 25 Connect fire hydrants to the main with a 6" valve and branch line having at least as much
26 cover as the distribution main. Set hydrants plumb with the pumper nozzle facing the
27 roadway and with the breakaway safety flange between 1" and 4" above the finished
28 surrounding grade. Except where otherwise approved, place hydrants into service as
29 soon as practicable. Place at least 7 cf of clean crushed stone around the base of the
30 hydrant to insure drainage of the hydrant barrel.
- 31 Where necessary, remove the hydrant shoe and replace with the appropriate type to
32 connect a relocated hydrant to the new pipe. Furnish and install or remove hydrant
33 extension pieces to provide the proper bury of the pipe and hydrant.
- 34 **(E) Line Stops**
- 35 Provide line stop valves to temporarily shut down the flow in pressurized pipes. Provide
36 line stops to temporarily dead end a pipeline when there are no available working valves
37 on the existing piping. Provide line stops with bypass to isolate a section of the existing
38 pipeline while maintaining the flow.
- 39 After line stop valves are removed, permanently cap the tapping sleeve and backfill the
40 entire excavation with compacted select material.
- 41 **(F) Air Release Valves**
- 42 Install air release valves at the high point of pressurized pipelines. Place a precast
43 manhole around air release valves.

1 **(G) Miscellaneous Controls**

2 Install corporation stops with tapping saddles for connecting 2" or smaller water lines to
 3 larger water lines. Install corporation stops at 45 ± 10 degrees from vertical on the larger
 4 line.

5 To aid in testing and flushing, install corporation stops at all elevated points along the
 6 pipeline to bleed off all entrapped air.

7 **1515-4 MEASUREMENT AND PAYMENT**

8 *Valves, Water Meters, Fire Hydrants, Line Stops* and other items listed in the pay items will
 9 be measured and paid per each for the appropriate size and type. Valves and other items on
 10 hydrant legs or service lines will not be measured or paid.

11 The term *Relocate* in a pay item means to physically move the existing item, either vertically
 12 or horizontally, using the appropriate materials to place the item into working order.
 13 Measurement and payment will be made per each for the appropriate size and type.

14 No additional compensation will be made for adjustments due to project staging on new or
 15 relocated items.

16 *Reconnect Water Meter* means to transfer or replace the piping from a new water line to
 17 an existing water meter that is not relocated. Measurement and payment will be made per
 18 each.

19 Valve boxes, meter boxes, hot boxes, vaults and manholes for protecting and servicing utility
 20 controls are incidental to the appropriate pay item.

21 A line stop with bypass consists of installing line stops on opposite ends of the piping to be
 22 isolated, tapping the piping beyond the line stops and providing temporary bypass piping
 23 between the taps. The entire assembly of valves and piping will be measured as one unit and
 24 paid per each.

25 Corporation stops or other items to aid in testing and flushing of the piping are incidental
 26 items.

27 If the contract does not include such pay items, measurement will not be done and the items
 28 will be incidental to other contract pay items. All piping, fittings, controls, certifications,
 29 appurtenances and other miscellaneous items necessary to place the new or relocated item in
 30 proper working condition are incidental.

31 Payment will be made under:

Pay Item	Pay Unit
___" Valve	Each
___" Tapping Valve	Each
___" Air release Valve	Each
___" Blow Off	Each
___" Water Meter	Each
Relocate Water Meter	Each
Reconnect Water Meter	Each
___" DCV Backflow Prevention Assembly	Each
Relocate ___" DCV Backflow Prevention Assembly	Each
___" RPZ Backflow Prevention Assembly	Each
Relocate ___" RPZ Backflow Prevention Assembly	Each
Fire Hydrant	Each
Relocate Fire Hydrant	Each
___" Line Stop	Each
___" Line Stop with Bypass	Each

Section 1520

**SECTION 1520
SANITARY SEWER**

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1520-1 DESCRIPTION

Provide sanitary sewers suitable for transporting sewage.

1520-2 MATERIALS

Refer to Division 10.

Item	Section
Sanitary Sewer Pipe and Fittings	1034

Use any pipe specified under Section 1034 except where a particular type pipe is specified in the plans or required by environmental regulations or Departmental policy. Verify the pipe is appropriate for the test pressure of the system and the external loading.

Use ductile iron fittings on pressurized (force main) pipelines 4" or larger.

Use screw type plastic or brass clean-out covers.

Use #12 AWG solid-copper wire with green insulation for the utility locator wires.

Use 2" plastic marking tape colored green with "Caution Sewer Line," or similar wording, permanently printed at 36" centers.

1520-3 CONSTRUCTION METHODS

Apply Section 1505 for excavation, trenching, pipe laying and backfill to sanitary sewer installation.

Assemble pipe in accordance with the recommendations of the manufacturer.

Install PVC pipe in accordance with approved bedding methods.

Install vitrified clay sewer pipe in accordance with **ASTM C12**.

Install 4" minimum diameter sanitary sewer clean-outs flush with finished grade on 4" and 6" service lines. Provide clean-outs at the right-of-way line and at changes in direction. Do not locate clean-outs within the roadway pavement or shoulders. Provide clean-outs no more than 50 ft apart when beyond the roadway shoulders.

Use ductile iron pipe for sewers with 10% or greater slope.

Install sewer lines entering manholes with the crown at or higher than the sewer line leaving the manhole.

Install small diameter pipe (4" or less) under existing pavement by a trenchless method at no additional compensation.

(A) Gravity Sanitary Sewer

Construct gravity sanitary sewers in conformance with *NCDENR Gravity Sewer Minimum Design Criteria*.

(1) Pipe Installation

Use fittings or saddles to connect service lines to the sewer main.

Maintain sewer flow at all times. Use temporary diversions or pumping to maintain flow when connecting proposed sewers to existing sewers. Use engineered temporary pumping systems capable of handling full pipe flow. Use pumping systems with automatic reliable operation or constantly tended manual operation.

1 (2) Testing
 2 Perform tests on newly installed sewers and altered sewers before placing into
 3 service. Provide all equipment, piping, controls, pumps, water and safety devices
 4 necessary for performing the tests.

5 Test all gravity sewer lines for leakage using one of the following methods:

6 (a) Infiltration

7 For sewer lines greater than 3 ft below groundwater, measure the amount of
 8 water infiltrating into the pipeline between manholes in at least 24 hours. Repair
 9 leaks or replace piping when the rate of infiltration exceeds the following
 10 equation:

$$W = 0.000789LD$$

Where:

- W** = maximum allowable leakage in gallons per hour
- L** = length of pipeline tested, in feet
- D** = nominal diameter of the pipe, in inches

11 (b) Exfiltration

12 For sewer lines above groundwater, perform an exfiltration test on the pipeline
 13 between manholes. Repair leaks or replace piping when the rate of exfiltration
 14 exceeds maximum allowable leakage calculated in Subarticle 1520-3(A)(2)(a).

15 The exfiltration test shall consist of securely plugging the pipe at the lower
 16 manhole and filling the pipeline with water. Allow the water to set for 24 hours
 17 in clay or concrete pipes. Raise the water level in the upstream manhole
 18 to 3 ft above the top of pipe. After 4 hours, measure the amount of water
 19 required to bring the water level back to the level at the start of the test and
 20 record the time.

21 Perform exfiltration tests through a series of manhole to manhole segments to
 22 limit the length of pipe tested to between 300 ft and 1,500 ft. Shorter sections
 23 may be tested with longer test times. No additional leakage allowance for
 24 manholes permitted.

25 (c) Air Test

26 Instead of hydrostatic testing, sewer lines 24" in diameter or smaller may be air
 27 tested in accordance with ASTM C828, ASTM C924 and the following. Securely
 28 plug the sewer pipe at the manholes. Fill the pipe with air to 4.0 psi
 29 and hold this pressure for 5 minutes. Reduce the pressure to 3.5 psi. Measure
 30 the time for the pressure to drop 1.0 psi to the new pressure of 2.5 psi. Exceed
 31 the minimum test time in Table 1520-1 for the appropriate nominal pipe
 32 diameter.

TABLE 1520-1 AIR TEST TIME			
Pipe Size (Inches)	Test Time (Minutes/100 ft)	Pipe Size (Inches)	Test Time (Minutes/100 ft)
8	1.2	18	2.4
10	1.5	21	3.0
12	1.8	24	3.6

33 (d) Visual Inspection

34 Visually inspect sewer lines larger than 24" from the inside using approved
 35 cameras. Correct any leakage, rolled gaskets or defects.

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1 (e) Line and Grade

2 Test all sewers for straight alignment by lamping or using a laser.

3 (f) Deflection Testing

4 Perform deflection tests on all flexible pipes. Conduct the test after the final
5 backfill has been in place at least 30 days to permit stabilization of the soil-pipe
6 system. As an alternative to waiting 30 days to permit stabilization of the
7 soil-pipe system, provide certified soil testing verifying the backfill of the trench
8 has been compacted to at least 95% maximum density.

9 No pipe shall exceed a deflection of 5%. If deflection exceeds 5%, relay the
10 pipe.

11 The rigid ball or nine-point mandrel used for the deflection test shall have
12 a diameter not less than 95% of the base inside diameter or average inside
13 diameter of the pipe depending on which is specified in the ASTM, to which the
14 pipe is manufactured. The pipe shall be measured in compliance with
15 ASTM D2122. The test shall be performed without mechanical pulling devices.

16 **(B) Force Main Sanitary Sewer**

17 Construct force main sewers in conformance with *NCDENR Minimum Design Criteria*
18 *for the Fast-Track Permitting of Pump Stations and Force Mains.*

19 (1) Installation

20 Install lines with 36" to 42" of cover to finished grade unless otherwise directed or
21 approved. Install lines with greater cover for short distances to accommodate utility
22 controls, to make tie-ins to existing facilities, to eliminate high points in the pipeline
23 or to provide clearance from existing or proposed utilities, drainage, other obstacles
24 or actual field conditions.

25 Provide automatic air release valves at all high points.

26 (2) Testing

27 Perform pressure and leakage tests on newly installed force mains and altered sewers
28 before placing such pipelines into service. Provide all equipment, piping, controls,
29 pumps, water and safety devices necessary for performing the tests and sterilization.

30 Test all new sewer force mains with clean water at 200 ± 5 psi for a 2 hour duration.
31 Vent all high points and expel all air. Provide certified results demonstrating leakage
32 less than:

$$W = 0.000106LD$$

Where:

- W** = allowable leakage in gallons per hour
L = length of pipeline tested, in feet
D = nominal diameter of the pipe, in inches

33 Repair leaks using approved methods or replace pipe, controls or appurtenances as
34 necessary to reduce leakage. Additionally, repair any leaks that are visible after
35 2 hours duration.

36 **1520-4 MEASUREMENT AND PAYMENT**

37 ___" *Sanitary Gravity Sewer* and ___" *Force Main Sewer* will be measured from end to end in
38 place with no deduction for length through manholes, valves or fittings and paid per linear
39 foot for the appropriate size. Where two different sizes enter or go from a manhole, each size
40 will be measured to the center of the manhole. Unless otherwise shown in the plans, branch
41 connections, ells or other fixtures will be included in the length measurement.

1 *Sanitary Sewer Clean-Out* will be measured and paid per each. No measurement or payment
2 of service lines will be made.

3 Payment will be made under:

Pay Item	Pay Unit
__" Sanitary Gravity Sewer	Linear Foot
__" Force Main Sewer	Linear Foot
Sanitary Sewer Clean-Out	Each

4 **SECTION 1525**
5 **UTILITY MANHOLES**

6 **1525-1 DESCRIPTION**

7 Provide utility manholes on water and sanitary sewer lines.

8 **1525-2 MATERIALS.**

9 Refer to Division 10.

Item	Section
Brick	1040-1
Concrete Block	1040-2
Curing Agents	1026
Gray Iron Castings	1074-7(B)
Mortar	1040-8
Portland Cement Concrete	1000
Precast Concrete Units	1077
Reinforcing Steel	1070
Select Material	1016
Steps	1074-8
Structural Steel	1072

10 Use precast concrete manholes with monolithic bottoms which conform to ASTM C478,
11 AASHTO M 199 and are as shown in the plans or in *Roadway Standard Drawings*. Use
12 ASTM C443 gaskets or AASHTO M 198 flexible sealants for joints between precast manhole
13 sections. Use resilient connectors for piping conforming to ASTM C923. Use ASTM A48,
14 Class 35 cast iron or Grade 60 steel reinforcement steps with polypropylene plastic coating.

15 Use manhole frames and covers made of cast iron conforming to ASTM A48 Class 35, which
16 are traffic bearing, have machined contact surfaces and are sized as shown. Use covers with
17 two 1" diameter air vents for vented manholes and use solid, non-vented covers with gaskets
18 for watertight installation. Use covers with "Sanitary Sewer" or "Water" cast in large letters
19 as appropriate for the type of utility.

20 Use an approved, nonshrink cement grout. Contact Materials and Tests Unit for a list of
21 approved packaged grouts.

22 **1525-3 CONSTRUCTION METHODS**

23 Apply Section 1505 for excavation, trenching, pipe laying and backfill.

24 Make connections of pipe to manholes in cored or precast holes using a resilient connector.
25 Use horseshoe type holes only when approved. For horseshoe type holes wrap the pipe with
26 a butyl rubber gasket and fill the space between the pipe and manhole with a non-shrinking
27 grout.

28 Provide an outside drop assembly on manholes for sewer pipes entering with 2.5 ft or more
29 vertical drop. Inside drop assemblies may be used for connections to existing manholes when
30 the drop exceeds 5 ft and the manhole diameter is greater than 4 ft.

Section 1525

- 1 In sewer manholes over 3 ft in depth, provide steps spaced 16" on center. Install steps in line
- 2 with the effluent opening unless otherwise specified.
- 3 Construct invert channels to confine and direct the flow through sanitary sewer manholes.
- 4 Use smooth finished invert channels that provide easy transition from inlet to outlet. Finish
- 5 the benches or shelves to a non-slip texture and slope toward the invert channel. Precast
- 6 invert channels are recommended but not required.
- 7 On deep manholes, a transition type manhole may be used provided there is at least 6 ft from
- 8 the manhole bench to the transition cone.
- 9 Construct manholes with the top of the cover as shown in Table 1525-1.

TABLE 1525-1 MANHOLE CONSTRUCTION	
Location	Top height above finished grade
Roadway pavement, Driveways, Sidewalks, Parking lots	Flush ± 1/4"
Vehicle Recovery Area	Flush ± 3"
Manicured Areas, such as lawns	Flush to + 2" with concrete pad
Flood Zones less than 3 ft above finished grade	1 ft above 100 year flood elevation
Flood Zones greater than 3 ft above finished grade	2 ft above finished grade with watertight frame and cover and vent pipe to 1 ft above 100 year flood
Other areas	2 ft above finished grade

10 For manholes installed before finished grading or paving, construct the top flush with the
 11 current grade to provide access during all phases of construction and adjust as grading and
 12 paving work progresses in accordance with Section 858.

13 **(A) Cast-In-Place Concrete, Brick and Block Masonry**

14 Construct concrete manholes in accordance with Section 825 with an ordinary surface
 15 finish. Construct brick masonry in accordance with Section 830. Furnish and place
 16 reinforcing steel in accordance with Section 425. Construct block masonry in accordance
 17 with Section 834 except that reinforcing will not be required.

18 Where necessary to fit field conditions, vary the dimensions of the manhole and footings
 19 as directed.

20 **(B) Installation of Precast Units**

21 Assemble precast manhole units in accordance with the manufacturer's instructions and
 22 grout together to form a sound structural unit. Fill all lifting holes with non-shrink grout.
 23 Where it is necessary to use cast-in-place, brick masonry or block masonry construction
 24 as part of the structure, apply Subarticle 1525-3(A) to such construction.

25 **(C) Fittings and Connections**

26 Where fittings enter the manhole, place them as the work is built up, thoroughly bonded
 27 and accurately spaced and aligned.

28 Make pipe connections so that the pipe does not project beyond the inside wall of the
 29 manhole and grout smooth and uniform surfaces on the inside of the manhole.

30 Set metal frames for covers in full mortar beds and mechanically secure by an approved
 31 method.

1 **(D) Testing**

2 Vacuum test all manholes before grouting and backfilling. Test according to
3 ASTM C1244.

4 **1525-4 MEASUREMENT AND PAYMENT**

5 The height of the manhole will be measured and paid to the nearest tenth of a foot from the
6 inside bottom (invert) of the manhole to the final finished top of the manhole ring.

7 Utility manholes will be measured and paid by appropriate diameter per each for manholes of
8 0 to 6 ft height and per linear foot of height over 6 ft. No additional payment will be made for
9 adjusting manholes to finished grade.

10 Drop assemblies will be incidental to the work being performed.

11 Payment will be made under:

Pay Item	Pay Unit
__' Dia Utility Manhole	Each
Utility Manhole Wall __' Dia	Linear Foot

12

SECTION 1530

13

ABANDON OR REMOVE UTILITIES14 **1530-1 DESCRIPTION**

15 Abandon or remove utility facilities.

16 **1530-2 MATERIALS**

17 Refer to Division 10.

Item	Section
Flowable Fill	1000-6
Portland Cement Concrete	1000
Select Materials	1016

18 **1530-3 CONSTRUCTION METHODS**

19 Apply Section 1505 for excavation, trenching, pipe laying and backfill.

20 **(A) Abandoning Pipe**

21 Abandon utility pipes shown in the plans or designated by the Engineer by emptying the
22 pipeline contents and plugging the ends with grout or flowable fill. Prepare grout to
23 a consistency that will flow and be vibrated in order for the mix to flow uniformly into
24 the pipe to be filled. Use the construction methods in Article 340-3.

25 Fill or remove the following abandoned utility pipes:

26 (1) Pipe larger than 24".

27 (2) Pipe located within the roadway typical section or the project slope stake line and
28 one of the following:

29 (a) Pipe 12" to 24" diameter located less than 20 ft below finished grade.

30 (b) Pipe 6" to 12" diameter located less than 12 ft below finished grade and not
31 made of cast iron, ductile iron, HDPE or PVC.

32 (c) Located below groundwater table that could become a conduit for water
33 movement.

Section 1530

1 Excavate, remove and dispose of properly any abandoned pipe to be removed. Backfill
2 the resulting trench and properly compact using local excavated material or select backfill
3 as required.

4 Fill abandoned pipe with grout or flowable fill to at least 90% full or completely when on
5 railroad right of way.

6 Remove any abandoned utility pipe exposed by grading operations to a minimum depth
7 of 12" below subgrade elevation of the proposed roadbed or completed grading template.

8 Plug all abandoned utility pipes. Use grout to plug all abandoned utility pipes at the
9 entrance to all manholes whether the manhole is to be abandoned or not. Use grout to
10 plug all abandoned water mains after new mains are placed in service.

11 **(B) Abandoning Manholes**

12 Abandon utility manholes in the construction limits by removing the top of the manhole
13 to the manhole spring line or to an elevation of 2 ft below the roadway subgrade,
14 whichever is greater and filling the manhole barrel with approved material.

15 Plug connecting utility pipes before filling or removing the manhole.

16 Remove the manhole taper, wall and base on all manholes to be removed.

17 Removed frames and covers become the property of the Contractor for proper disposal.

18 **(C) Remove Water Meter**

19 Remove water meters by disconnecting and plugging the water service piping at the
20 source main and plugging the piping at the right-of-way line. Return the meter to the
21 utility owner. Dispose of all other parts, piping and boxes.

22 **(D) Remove Fire Hydrant**

23 Remove fire hydrants by disconnecting and plugging the hydrant leg piping as close to
24 the water main as possible. If the hydrant valve is within 4 ft of the main, close the valve,
25 plug the outlet side of the valve and remove the valve box.

26 Removed hydrants become the property of the Contractor for proper disposal.

27 **1530-4 MEASUREMENT AND PAYMENT**

28 Utility pipe that is abandoned by filling or removal will be measured and paid by the linear
29 foot for the size of pipe. Utility pipe that is abandoned by plugging the ends only and leaving
30 in place will not be measured or paid. Grout used for plugging of abandoned utility pipe is
31 incidental to the work being performed. Utility pipe that is removed by other work of the
32 contract will be incidental to the other work.

33 *Abandon Utility Manhole* will be measured and paid per each.

34 *Remove Utility Manhole* will be measured and paid per each.

35 *Remove Water Meter* and *Remove Fire Hydrant* will be measured and paid per each.

36 Payment will be made under:

Pay Item	Pay Unit
Abandon ___" Utility Pipe	Linear Foot
Abandon Utility Manhole	Each
Remove Utility Manhole	Each
Remove Water Meter	Each
Remove Fire Hydrant	Each

**SECTION 1540
ENCASEMENT**

1

2

3 **1540-1 DESCRIPTION**

4 Furnish and install encasement or casing pipes. For the purposes of this specification the
5 words encasement, casing, encasement pipe and casing pipe are interchangeable.

6 **1540-2 MATERIAL**

7 Refer to Division 10.

Item	Section
Concrete Pipe	1034-3
Flowable Fill	1000-6
Grout	1003
PVC Pipe	1034-2
Select Materials	1016
Steel Encasement Pipe	1036-4(B)
Treated Timber	1082-3
Vitrified Clay Pipe	1034-1

8 Other pipe as designed by an engineer licensed by the State of North Carolina.

9 Submit material certifications and obtain approval from the Engineer before installation.

10 **1540-3 CONSTRUCTION METHODS**11 **(A) Open Cut**

12 Apply Section 1505 for excavation, trenching, pipe laying and backfill.

13 **(B) Welding**

14 Weld in accordance with Article 1032-5.

15 **(C) Marker Posts**

16 Mark encasements for future use with a treated wooden marker post. Place wooden
17 marker post at the right of way or at the ends of encasements if encasements extend
18 beyond the right of way.

19 **(D) Carrier Pipe Installation**

20 Install carrier pipe through casing using spacers or insulators to support the carrier pipe.
21 Place spacers at intervals sufficient to support the carrier pipe without sagging. Install
22 spacers sized to raise the carrier pipe bells above the encasement pipe invert.

23 Seal ends of casing with concrete, brick or other approved materials. Ensure drainage of
24 encasement by leaving a 1" diameter weep hole in the seal of the lower end of the
25 encasement.

26 **(E) Casing Pipe Fill**

27 Pump or place flowable fill; grout; or Class III Type 1, Class IV or Class V select
28 materials into the annular void between the carrier pipe and casing pipes 36" or larger.

29 **1540-4 MEASUREMENT AND PAYMENT**

30 ___" *Encasement Pipe* will be measured from end to end and paid at the contract unit price per
31 linear foot for each size.

32 Payment will be made under:

Pay Item	Pay Unit
___" Encasement Pipe	Linear Foot

Section 1550

**SECTION 1550
TRENCHLESS INSTALLATION OF UTILITIES**

1550-1 DESCRIPTION

Install pipe using a trenchless method. Pipe refers to the specified pipe, which may be the primary carrier pipe or an encasement pipe. Shoring means the earth support system used for installing the pipe. The terms for encasement, casing, encasement pipe and casing pipe are interchangeable. Casing is considered shoring except where specified.

An engineer licensed by the State of North Carolina shall design the method and certify the work will not damage the roadway above or endanger the roadway user.

1550-2 MATERIAL

Refer to Division 10.

Item	Section
Concrete	1000
Encasement Pipe	1540
Flowable Fill	1000-6
Structural Timber	1082
Structural Steel	1072
Treated Timber	1082-2

Use pipe joints that are modified to suit the installation method. Provide engineering calculations for piping and shoring. Submit material certifications and obtain approval from the Department’s Engineer before installation.

Use steel or concrete liner plates. Steel tunnel liner plates shall meet Sections 16 and 25 in *AASHTO LRFD Bridge Design Specifications*. Concrete liner plates shall meet AASHTO specifications.

Drilling fluids consist of water, bentonite and polymer additives.

Other materials will be considered with adequate design and quality control.

1550-3 CONSTRUCTION METHODS

(A) General

Apply Section 1505 for excavation, trenching, pipe laying and backfill.

Install the pipe to the lines and grades shown in the plans. Use workers that are skilled in the method of construction. Construct with good workmanship by skilled workers along with proper safety precautions.

Locate ends of trenchless construction and pits beyond the vehicle recovery area of the roadway. The vehicle recovery area may be reduced using acceptable traffic control methods.

(B) Design

Assess soil conditions expected during trenchless operations.

Use a trenchless method appropriate for the field conditions and for the specified pipe. Design the method to insure no settlement of the pipe or the completed roadway section. Use methods of construction and installation that will not disturb the soils outside of the immediate vicinity of the pipeline or pits.

1 Before construction, provide detailed plans for the method of installation certified by
 2 an engineer licensed by the State of North Carolina. Provide certified calculations
 3 demonstrating the method of installation as safe and of minimal risk. Provide certified
 4 calculations of the structural adequacy of all materials. The design shall meet
 5 *AASHTO LRFD Bridge Design Specifications*. An engineer licensed by the State of
 6 North Carolina shall certify changes or modifications to the designed method as needed
 7 for actual field conditions.

8 (C) Water Control

9 Provide groundwater control and removal as appropriate for the method of excavation
 10 and installation. Remove the groundwater using an engineered dewatering system. Keep
 11 surface waters out of the excavation and pits.

12 (D) Shoring

13 Maintain continuous and active support (shoring) to the soils surrounding both the pit and
 14 the trenchless excavation. Provide temporary or permanent shoring, as needed. Provide
 15 temporary shoring to maintain the hole or pit excavation for the duration of the work.
 16 Casing pipe 36" and larger, tunnel liner, pit and trench shoring and shoring that is not
 17 certified for permanent use is considered temporary. Provide permanent shoring when
 18 desired or specified to maintain the open hole for an indefinite time. Permanent shoring
 19 requires certification of durability and a design life of 100+ years.

20 Fill all voids around the excavation and shoring with structural fill material as work
 21 progresses. Fill the annular space between the specified pipe and temporary shoring.

22 Either work continuously (24 hours/day and 7 days/week) on the operations from the
 23 time the excavation begins through the filling of voids or use an engineered system for
 24 shoring the excavation during work stoppage.

25 (E) Pre-Construction Meeting

26 The Contractor shall conduct a pre-construction meeting with the Department's Engineer
 27 to review the proposed method for installation of the pipe. Conduct the meeting at least
 28 48 hours before beginning installation. The meeting shall consist of, but is not limited to:

- 29 (1) Presentation of the construction methods for understanding by all involved,
- 30 (2) Presentation of methods for filling any potential voids around the pipe,
- 31 (3) Advising the Department's Engineer of any work to be observed for "Not In Soil"
 32 classification,
- 33 (4) Demonstrating that appropriate equipment and materials are on site,
- 34 (5) Providing a progress schedule, and
- 35 (6) Demonstrating ability to react to failures or roadway settlement.

36 1550-4 TRENCHLESS METHODS

37 (A) Bore and Jack

38 For bore holes up to 6" diameter in stable ground, the hole may be augured and the pipe
 39 pushed or jacked through the cleaned out hole. For bore holes greater than 6", provide
 40 continuous support of the hole by simultaneously jacking the pipe or casing into the hole.

41 Use equipment suitably sized and designed to simultaneously bore or drill the soil or rock
 42 while pushing or jacking pipe on a controlled grade. Position the cutter head within one
 43 diameter of the leading edge of the pipe. In cohesive, dense and dry soils and rock,
 44 position the cutter head in front of the leading edge. In non-cohesive or loose soils,
 45 position the cutter head inside the pipe.

Section 1550

- 1 Dry bore only, do not use jetting or wet boring methods. Use drilling fluids only on the
- 2 outside of pipe for lubrication or hole stabilization.
- 3 Minimize over bore, match cutter diameter to the outside diameter of the encasement
- 4 pipe. Limit overbore to 5% of bore diameter or 2", whichever is less.
- 5 Provide steering controls as necessary to maintain line and grade.

6 (B) Directional Drilling

- 7 For drilled holes up to 6" diameter in stable ground, the hole may be drilled and reamed
- 8 followed by pulling the pipe into the hole within 8 hours. For drilled holes greater than
- 9 6", simultaneously pull the pipe or casing into the hole as reaming occurs. Multi-pass
- 10 reaming larger than 6" requires certification by the Contractor's engineer that the soils are
- 11 self-supporting of the dead and live loads.
- 12 When under pavement or within a one horizontal to one vertical distance from pavement,
- 13 maintain the depth of cover in Table 1550-1.

TABLE 1550-1		
DEPTH OF COVER FOR DIRECTIONAL DRILLING		
Drilled Hole Diameter	Single Pass Reaming Minimum Depth of Cover	Multi-Pass Reaming Minimum Depth of Cover
2" to 6"	4 ft	4 ft
> 6"to 22"	8 times the hole diameter	12 times the hole diameter
> 22"to 32"	15 ft	25 ft

- 14 Begin bores at locations that allow transitioning the bore to meet the above depths.
- 15 Use drilling fluids as appropriate for the type soils. Pump drilling fluids only while
- 16 drilling or reaming. Monitor flow rates to match the amount leaving the bore hole. Do
- 17 not increase pressure or flow to free stuck drillheads, reamers or piping.
- 18 Limit drilled or reamed holes to 2" larger than the pipe.

19 (C) Tunneling

- 20 Tunnel using hand mining or mechanical excavation. Use tunnel shields or fore poling
- 21 along with benched excavation and breast boarding as appropriate for the field
- 22 conditions. Alternatively, the Contractor's engineer may certify that the soils are
- 23 self-supporting of the dead and live loads and design tunneling methods as appropriate.
- 24 Provide active support to the tunnel walls. Shore tunnel walls using liner plates, steel ribs
- 25 with lagging or other engineered method or by jacking piping into place.
- 26 Limit over excavation to 1" larger than the liner or shield. Grout the external voids as
- 27 work progresses and as specified by the Contractor's engineer.

28 (D) Pipe Ramming

- 29 Use pipe ramming only where soils are homogeneous and free of rock, boulders, stumps
- 30 and debris. Do not use in the vicinity of quick or liquefiable soils.
- 31 Steel bands 1/2" thick are allowed on the outside of the leading edge of the pipe or casing
- 32 to oversize the hole to reduce friction. Steel bands 1/2" thick may be used on the inside
- 33 to compact the spoil and to prevent plugging.
- 34 Install at the following minimum depth of cover.

TABLE 1550-2	
DEPTH OF COVER FOR PIPE RAMMING	
Pipe or Casing Diameter	Minimum Depth of Cover
2" to 6"	4 ft
> 6" to 14"	6 pipe diameters
>14" to 24"	8 ft

1 Contain spoil within the casing during ramming. After completion, use compressed air or
2 augers to remove the spoil. Clean the interior using a pig. Provide appropriate safety
3 devices. Limit air pressure to less than the rating of the pipe or casing.

4 Use lubricants and surfactants as needed.

5 **(E) Other Methods**

6 Other methods will be considered on a case by case basis when thoroughly engineered.

7 **(F) Lubrication and Drilling Fluids**

8 Use drilling fluids for lubrication as needed at low pressure, low flow and low volume.
9 Do not use water alone. Low pressure is less than the weight of the soil above the
10 excavation. Low flow is less than one gallon per minute. Low volume is less than the
11 calculated annular space between the piping and excavated hole.

12 **1550-5 QUALITY CONTROL**

13 The Contractor, at no cost to the Department, shall replace or repair damaged or defective
14 installations. The method to be used shall be designed by the Contractor's engineer and
15 approved by the Engineer.

16 **(A) Ground Movement**

17 Before excavation, establish control points for measuring settlement of the road at 10 ft
18 intervals along the centerline and 10 ft each side of the pipeline. A land surveyor
19 licensed in the State of North Carolina shall monitor these points daily until construction
20 is complete.

21 Cease trenchless operations when measured settlement exceeds 0.02 ft. Determine cause
22 of settlement and repair as necessary. Modify trenchless methods as needed.

23 **(B) Line and Grade**

24 Abandon and grout all pipes that are not at required alignment and grade in conformance
25 with Section 1530.

26 Trenchless installation of proposed water main may not vary more than 2% of total length
27 from required horizontal alignment, one foot from vertical alignment and shall maintain
28 minimum cover.

29 Trenchless installations for grade and alignment dependent pipes such as sewers may not
30 vary.

31 **(C) Leakage**

32 Control leakage through tunnel walls to minor seepage. Seal all leaks in pipes, casing or
33 other permanent shoring.

34 **(D) Roundness**

35 Provide permanent shoring with at least 95% of nominal diameter in all directions.

36 **(E) External Voids**

37 Fill all external voids greater than 2" high or 2 ft wide. Fill with compacted flowable fill,
38 grout or Class II or III select material.

Section 1550

1 **1550-6 MEASUREMENT AND PAYMENT**

2 *Trenchless Installation of _____ in Soil* will be measured and paid in linear feet. Measurement
3 will be made horizontally to the nearest tenth of a linear foot.

4 *Trenchless Installation of _____ Not in Soil* will be measured and paid in linear feet.
5 Measurement will be made horizontally to the nearest tenth of a linear foot.

6 Trenchless installations will be considered “In Soil” unless classified as “Not in Soil” by
7 observation of the Engineer. “Not in Soil” is all material other than soil as determined and
8 observed by the Engineer. It is the Contractor’s responsibility to request and obtain the
9 Department’s Engineer’s observation for installations “Not in Soil.”

10 Measurement will be made along utility pipes with required trenchless installation. Payment
11 for trenchless installation will be made as additional compensation for utility piping with
12 contract pay items of the various sizes. No additional payment will be made for access pits or
13 shoring. No payment will be made for abandoning defective installations.

14 Payment will be made under:

Pay Item

Trenchless Installation of _____ in Soil

Trenchless Installation of _____ Not in Soil

Pay Unit

Linear Foot

Linear Foot

DIVISION 16

EROSION CONTROL AND ROADSIDE DEVELOPMENT

SECTION 1605

TEMPORARY SILT FENCE

1605-1 DESCRIPTION

Furnish material, construct, maintain and remove temporary silt fence in locations shown in the plans or in locations that require surface drainage to be filtered.

1605-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile, Type 3	1056

(A) Posts

Provide steel posts with at least 5 ft long, 1 3/8" wide measured parallel to the fence and 1.25 lb/ft in weight per length. Equip with an anchor plate with an area of at least 14.0 sq.in. Ensure a means of retaining fencing material in the desired position without displacement.

(B) Woven Wire Fence

Provide woven wire fence at least 32" high with 5 horizontal wires, vertical wires spaced 12" apart, 10 gauge top and bottom wires and 12 1/2 gauge for all other wires.

(C) Attachment Device

Provide No. 9 staple with at least 1 1/2" length or other approved attachment device.

1605-3 CONSTRUCTION METHODS

Install in locations as shown in the plans or as directed.

Install wire and geotextile as shown in *Roadway Standard Drawings*.

Geotextile may be used without the woven wire fence backing under the following conditions:

(A) The Engineer will approve the geotextile.

(B) Incline post spacing toward the runoff source, at an angle of not more than 20° from vertical.

(1) Attach geotextile to the post with wire or other acceptable methods.

(2) Overlap geotextile at least 18" at splice joints.

(3) Install geotextile that is free of defects, rips, holes, flaws, deterioration or damage.

1605-4 MAINTENANCE AND REMOVAL

Maintain the silt fence until the project is accepted or until the fence is removed. Remove and replace deteriorated or ineffective geotextile. Remove and dispose of silt accumulations in accordance with Section 1630 when necessary or as directed.

Leave silt fence in place until site stabilization and remove at project completion. Removed silt fence becomes the property of the Contractor. Dress and seed and mulch all areas where silt fence is removed in accordance with Section 1660.

Section 1606

1 **1605-5 MEASUREMENT AND PAYMENT**

2 *Temporary Silt Fence* will be measured and paid in linear feet, accepted in place, along the
3 ground line of the fence.

4 *Silt Excavation* will be measured and paid in accordance with Section 1630.

5 *Seeding and Mulching* will be measured and paid in accordance with Section 1660.

6 Article 104-5, pertaining to revised contract prices, will not apply to this item. No revision in
7 the contract unit price will be allowed because of any overrun or underrun.

8 Payment will be made under:

Pay Item	Pay Unit
Temporary Silt Fence	Linear Foot

9 **SECTION 1606**
10 **SPECIAL SEDIMENT CONTROL FENCE**

11 **1606-1 DESCRIPTION**

12 Furnish materials, construct, maintain and remove special sediment control fence. Place
13 special sediment control fence as shown in the plans or as directed.

14 **1606-2 MATERIALS**

15 Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005

16 **(A) Posts**

17 Provide steel posts in accordance with Subarticle 1605-2(A).

18 **(B) 1/4" Hardware Cloth**

19 Provide hardware cloth with 1/4" openings constructed from 24 gauge wire.

20 **(C) Attachment Device**

21 Provide No. 9 staple with at least 1 1/2" length or other approved attachment device.

22 **1606-3 CONSTRUCTION METHODS**

23 Install hardware cloth and sediment control stone in accordance with *Roadway Standard*
24 *Drawings* No. 1606.01. Attach hardware cloth to post with wire staple or other acceptable
25 methods.

26 Maintain the special sediment control fence until the project is accepted or until the fence is
27 removed. Remove and dispose of silt accumulations at the fence when so directed in
28 accordance with Section 1630.

29 **1606-4 MEASUREMENT AND PAYMENT**

30 *Silt Excavation* will be measured and paid in accordance with Section 1630.

31 *1/4" Hardware Cloth* will be measured and paid in accordance with Article 1632-5.

32 *Sediment Control Stone* will be measured and paid in accordance with Article 1610-4.

SECTION 1607
GRAVEL CONSTRUCTION ENTRANCE

1607-1 DESCRIPTION

Furnish, install, maintain and remove all material required for the construction of a gravel construction entrance.

1607-2 MATERIALS

Refer to Division 10.

Item	Section
Stone for Erosion Control, Class A	1042
Geotextile for Drainage, Type 2	1056

1607-3 CONSTRUCTION METHODS

Install a gravel construction entrance in accordance with *Roadway Standard Drawings* No. 1607.01 and at locations as directed. Install gravel construction entrances in a way to prevent vehicles from bypassing the construction entrance when leaving the project site.

1607-4 MEASUREMENT AND PAYMENT

Geotextile for Drainage will be measured and paid in accordance with Article 876-4.

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Such price and payment shall be full compensation for all work covered by this section including all materials, construction, maintenance and removal of a gravel construction entrance.

SECTION 1610
STONE FOR EROSION CONTROL

1610-1 DESCRIPTION

Furnish, stockpile if directed, place and maintain an approved stone for construction of erosion control devices at ditches, diversions, swales, pipe inlets, pipe outlets, drainage turnouts and at other locations designated in the plans or as directed. The work includes, but is not limited to, furnishing, weighing, stockpiling, re-handling, placing and maintaining stone; and disposal of any stone not incorporated into the project when necessary.

1610-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class A or Class B	1042-1

1610-3 CONSTRUCTION METHODS

Place stone, in locations and to the thickness, widths and lengths as shown in the plans or as directed. Construct erosion control devices in accordance with the plans neatly and uniformly with an even surface and meeting the plans.

1610-4 MEASUREMENT AND PAYMENT

Stone For Erosion Control, Class __ will be measured and paid in tons of each class of stone incorporated into the work, or has been delivered to and stockpiled on the project as directed. Stone placed in the stockpile will not be measured a second time. Measure stone by weighing in trucks on certified platform scales or other certified weighing devices.

Section 1615

1 *Sediment Control Stone* will be measured and paid in tons of stone incorporated into the work,
2 or has been delivered to and stockpiled on the project as directed. Stone placed in the
3 stockpile will not be measured a second time. Measure stone by weighing in trucks on
4 certified platform scales or other certified weighing devices.

5 Payment will be made under:

Pay Item	Pay Unit
Stone For Erosion Control, Class __	Ton
Sediment Control Stone	Ton

6 **SECTION 1615**
7 **TEMPORARY MULCHING**

8 **1615-1 DESCRIPTION**

9 Furnish, place and secure mulch material to prevent excessive soil erosion during construction
10 operations where it is impossible or impractical to perform permanent seeding and mulching.

11 The actual conditions which occur during the construction of the project will determine the
12 quantity of mulching. The quantity of mulching may be increased, decreased or eliminated
13 entirely as directed. Such variations in quantity will not be considered as alterations in the
14 details of construction or a change in the character of work.

15 **1615-2 MATERIALS**

16 Refer to Division 10.

Item	Section
Mulch for Erosion Control	1060-5

17 Use undiluted emulsified asphalt or other approved tacking material.

18 **1615-3 CONSTRUCTION METHODS**

19 Place temporary mulch promptly at locations on temporarily seeded or non-seeded areas when
20 so directed.

21 Spread mulch uniformly over the area by hand or by means of appropriate mechanical
22 spreaders or blowers to obtain a satisfactory uniform cover. A satisfactory application of
23 temporary mulch on non-seeded areas consists of a sufficient amount to completely and
24 uniformly cover the ground.

25 When temporary mulching is performed in conjunction with temporary seeding, apply mulch
26 in accordance with Article 1660-6. Complete mulching and tacking within 24 hours of
27 temporary seeding work. Exercise care to prevent displacement of soil and seed or other
28 damage to areas where temporary seeding is done.

29 Apply a sufficient amount of asphalt or other type binding material when using grain straw to
30 assure that the temporary mulch is properly held in place. Take adequate precautions to
31 prevent damage to traffic, structures, guardrails, traffic control devices or any other
32 appurtenances during the application of binding material. Provide adequate covering or
33 change methods of application as required to prevent such damage. Repair any damage that
34 occurs, including any necessary cleaning.

35 Take sufficient precautions to prevent mulch from entering drainage structures through
36 displacement by wind, water or other causes and promptly remove any blockage to drainage
37 facilities.

38 **1615-4 MEASUREMENT AND PAYMENT**

39 *Temporary Mulching* will be measured and paid in acres, measured along the surface of the
40 ground over which temporary mulch has been placed as directed and accepted.

1 Payment will be made under:

Pay Item	Pay Unit
Temporary Mulching	Acre

2

SECTION 1620

3

TEMPORARY SEEDING

4 1620-1 DESCRIPTION

5 Seed and mulch selected areas in advance of the permanent seeding and mulching operations
6 to minimize erosion of graded areas during construction operations. The work includes
7 preparing seedbeds; furnishing, placing and covering fertilizer and seed; furnishing and
8 placing mulch; and other operations necessary for seeding the required areas.

9 Perform temporary seeding promptly at the locations and under any of the following
10 conditions when directed:

11 (A) When it is impossible or impractical to bring an area to the final line, grade and finish so
12 that permanent seeding and mulching operations can be performed without subsequent
13 serious disturbance by additional grading;

14 (B) When erosion occurs or is considered to be potentially substantial on areas of graded
15 roadbed where construction operations are temporarily suspended or where the grading of
16 the roadbed has been completed substantially in advance of the paving construction;

17 (C) During seasons of the year when permanent seeding and mulching is prohibited by the
18 contract;

19 (D) When an immediate cover would be desirable to minimize erosion, siltation or pollution
20 on any area.

21 The actual conditions that occur during the construction of the project will determine the
22 quantity of seed or fertilizer to be used. The quantity of seed or fertilizer may be increased,
23 decreased or eliminated entirely as directed. Such variations in quantity will not be
24 considered as alterations in the details of construction or a change in the character of the
25 work.

26 1620-2 MATERIALS

27 Refer to Division 10.

Item	Section
Fertilizer	1060-2
Mulch for erosion control	1060-5
Seed	1060-4

28 See the contract for analysis of fertilizer and the kinds of seed.

29 1620-3 CONSTRUCTION METHODS

30 (A) Seedbed Preparation

31 Scarify areas to be seeded to a depth of not less than 5" unless directed otherwise. The
32 soil conditions and topography will determine the required depth of the seedbed.

33 Prepare the surface to be seeded with adequate furrows, ridges, terraces, trenches or other
34 irregularities in which seeding materials can lodge with reasonable assurance that the
35 materials will not be easily displaced by wind, rain or surface runoff.

36 (B) Applying and Covering Fertilizer and Seed

37 The analysis of fertilizer, the kinds of seed and the rates of application of fertilizer and
38 seed shall be as stated in the contract.

Section 1620

- 1 Apply no fertilizer or seed when the Engineer determines that conditions are unfavorable
- 2 for such operations.
- 3 Distribute the fertilizer or seed uniformly over the seedbed at the required rates of
- 4 applications.
- 5 Cover fertilizer and seed unless otherwise directed. If covering is required, provide it to
- 6 the depth acceptable to the Engineer for the prevention of displacement by wind, rain or
- 7 surface runoff.
- 8 Mulch all areas temporarily seeded, in accordance with Section 1615, unless otherwise
- 9 indicated in the contract or as directed.
- 10 Article 1660-5 will be applicable to the approval of equipment and the protection of
- 11 traffic, structures, guardrails, traffic control devices and other appurtenances.

12 **(C) Mowing and Repair of Temporary Seeding**

- 13 Maintain areas where temporary seeding is performed in a satisfactory condition,
- 14 including mowing at the locations and times as directed.
- 15 Repair areas of temporary seeding which have been damaged or have failed. Repair
- 16 includes reshaping or the placing of additional earth material and repeating the seeding
- 17 process.

18 **1620-4 MEASUREMENT AND PAYMENT**

- 19 *Seed for Temporary Seeding* will be measured and paid in pounds. The weight of seed will be
- 20 determined by bag count of standard weight bags or by weighing the seed.
- 21 *Fertilizer for Temporary Seeding* will be measured and paid in tons. The weight of dry
- 22 fertilizer will be determined by bag count of standard weight bags or by weighing the
- 23 fertilizer in trucks on certified platform scales or other certified weighing devices.
- 24 *Temporary Mulching* will be measured and paid in accordance with Section 1615.
- 25 *Mowing* will be measured and paid in accordance with Article 1660-8.
- 26 Where earthwork and temporary seeding have been adequately constructed, completely
- 27 drained and properly maintained, and damage occurs due to natural causes, the Contractor
- 28 will be paid at the contract unit price for the excavated material required for repairs to the
- 29 damaged earthwork and the contract unit prices for *Seed For Temporary Seeding* and
- 30 *Fertilizer for Temporary Seeding* for correcting the damaged temporary seeding.
- 31 Repair, at no cost to the Department, any damage to earthwork or temporary seeding which is
- 32 due to carelessness or neglect on the part of the Contractor.

33 Payment will be made under:

Pay Item	Pay Unit
Seed For Temporary Seeding	Pound
Fertilizer For Temporary Seeding	Ton

SECTION 1622
TEMPORARY SLOPE DRAINS

1622-1 DESCRIPTION

Furnish, place, maintain and remove temporary slope drains at the locations shown in the plans and at locations as directed. Work includes, but is not limited to, furnishing all pipe, anchor stakes and compacted earth; installation and removal of the slope drain; constructing the sump, earth shoulder berm and earth berm ditch block; constructing the stone inlet protection; constructing the outlet protection; and dressing, seeding and mulching the disturbed area after the slope drain and berm have been removed. Standard T-sections and elbows at the inlet of the slope drain pipe may be required as directed.

The actual conditions during the construction of the project will determine the quantity of temporary slope drains.

The quantity of temporary slope drains may be increased, decreased or eliminated entirely at the direction of the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1622-2 MATERIALS

Provide temporary slope drains, standard T-sections and elbows with pipe of sufficient size to carry the anticipated volume of water with a minimum diameter of 12". Provide plastic pipe and fittings meeting AASHTO M 294.

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class B	1042-1

1622-3 CONSTRUCTION METHODS

(A) Temporary Slope Drains

Install temporary slope drains in accordance with *Roadway Standard Drawings* No. 1622.01 during all phases of grading operations and adjust as needed to properly direct water flow.

Construct an earth berm at the top of cut and fill sections to direct water flow into temporary slope drains.

At locations of single direction water flow, locate temporary slope drain inlets in a sump along the earth berm. Construct an earth berm ditch block perpendicular to the direction of the water flow on the downstream side of the temporary slope drain. Construct ditch blocks of sufficient height to block the flow of water but at no higher elevation than the earth shoulder berm. Install an elbow at inlet of slope drain pipe as directed.

At locations of multi direction flow, install a sump on both sides of the slope drain inlet. Construct inlet protection with sediment control stone and Class B stone in accordance with *Roadway Standard Drawings* No. 1622.01. Install a standard T-section at the slope drain inlet as directed.

Join multiple pipe sections using an approved pipe coupling. Anchor slope drains in accordance with the *Roadway Standard Drawings* No. 1622.01. Extend slope drain to bottom of slope and erosion control measures.

Section 1630

1 **(B) Outlet Protection at Temporary Slope Drain**

2 Protect outlet locations subject to scour by placing Class B stone or a silt detention
3 device. A special stilling basin may also be used as outlet protection in accordance with
4 Section 1639 and as directed. Construct outlet protection devices as shown in the plans
5 and at other locations as directed.

6 **1622-4 MEASUREMENT AND PAYMENT**

7 *Temporary Slope Drains* will be measured and paid in linear feet of pipe, including inlets, tees
8 and elbows, measured along the invert of the temporary slope drain, completed and accepted.

9 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

10 *Stone for Erosion Control, Class ____* will be measured and paid in accordance with
11 Section 1610.

12 *Silt Excavation* will be measured and paid in accordance with Section 1630.

13 No payment will be made for temporary slope drains, that were required due to the
14 Contractor's negligence, carelessness or failure to install permanent controls as a part of the
15 work scheduled.

16 *Temporary Slope Drains* will be considered minor items. Article 104-5, pertaining to revised
17 contract unit prices for overrunning minor items, will not apply to these items.

18 Payment will be made under:

Pay Item	Pay Unit
Temporary Slope Drains	Linear Foot

19 **SECTION 1630**
20 **CONSTRUCTION AND MAINTENANCE**
21 **OF SILT DETENTION DEVICES**

22 **1630-1 DESCRIPTION**

23 Excavate and satisfactorily dispose of all materials excavated in the construction, cleaning out
24 and maintenance of silt basins, silt ditches and other silt detention devices. Work includes,
25 but is not limited to, excavation, shaping of the basins or ditches, cleaning out and
26 maintaining the basins or ditches, disposal of all materials and backfilling.

27 **1630-2 CONSTRUCTION METHODS**

28 **(A) General**

29 Excavate silt basins, silt ditches or other silt detention devices to the dimensions and at
30 the locations shown in the plans or as directed for the purpose of siltation control with
31 non-vertical side slopes and not greater than 1.5:1 slope. Clean out silt detention devices,
32 when so directed, to maintain their effectiveness. Backfill and shape for seeding and
33 mulching silt detention basins and silt ditches before completion of the project unless
34 otherwise directed.

35 **(B) Disposal of Materials**

36 Use all excavated materials in the construction of roadway embankments except where
37 otherwise directed. Dispose of materials, which are not used in the construction of
38 roadway embankments in waste areas in accordance with Section 802.

1 **1630-3 MEASUREMENT AND PAYMENT**

2 *Silt Excavation* will be measured and paid in cubic yards measured in the original position, of
 3 all materials excavated within the limits established by the plans or directed by the Engineer.
 4 If in the opinion of the Engineer it is not feasible to measure the excavated material in its
 5 original position, the volume will be determined by truck measurement in accordance with
 6 Subarticle 230-5, except that no deduction for shrinkage will be made.

7 The filling of silt basins or silt ditches will be paid as provided in Section 225 for *Unclassified*
 8 *Excavation* or in Section 230 for *Borrow Excavation*, depending on the source of the material
 9 used to fill the basins or ditches.

10 Payment will be made under:

Pay Item	Pay Unit
Silt Excavation	Cubic Yard

11 **SECTION 1631**
 12 **ROLLED EROSION CONTROL PRODUCTS**

13 **1631-1 DESCRIPTION**

14 Furnish, place and maintain a rolled erosion control product (matting) on previously shaped
 15 and seeded drainage ditches, slopes or other areas at locations shown in the contract or as
 16 directed. Work includes providing all materials, excavation and backfilling, placing and
 17 securing matting and maintaining the drainage ditch.

18 The conditions which occur during the construction of the project will determine the quantity
 19 of matting placed. The quantity of matting may be increased, decreased or eliminated entirely
 20 as directed. Such variations in quantity will not be considered as alterations in the details of
 21 construction or a change in the character of the work.

22 **1631-2 MATERIALS**

23 Refer to Division 10.

Item	Section
Matting for Erosion Control	1060-8
Staples	1060-8

24 **1631-3 CONSTRUCTION METHODS**

25 Place matting immediately following seeding. Provide a smooth soil surface free from stones,
 26 clods or debris that will prevent the contact of the matting with the soil. Preserve the required
 27 line, grade and cross section of the area covered.

28 Unroll matting in the direction of the flow of water and apply without stretching so that it will
 29 lie smoothly but loosely on the soil surface. Bury the up-channel or top of slope end of each
 30 piece of matting in a narrow trench at least 6" deep and tamp firmly. Where one roll of
 31 matting ends and a second-roll begins, overlap the end of the upper roll over the buried end of
 32 the second roll so there is a 4" overlap. Construct staple checks 4" on center and every 30 ft
 33 longitudinally in the matting or as directed. Fold over and bury matting to the full depth of
 34 the trench, close and tamp firmly. Overlap matting at least 4" where 2 or more widths of
 35 matting are laid side by side.

36 Place staples across matting at ends, junctions and check trenches approximately 10" apart.

37 Place staples along the outer edges and down the center of each strip of matting 3 ft apart.
 38 Place staples along all lapped edges 10" apart.

39 Install product with netting on the top side when excelsior or straw matting is used.

Section 1632

1 The Engineer may require adjustments in the trenching or stapling requirements to fit
2 individual cut or fill slope conditions.

3 **1631-4 MEASUREMENT AND PAYMENT**

4 *Matting* will be measured and paid in square yards as measured along the surface of the
5 ground, over which matting has been acceptably placed.

6 Payment will be made under:

Pay Item	Pay Unit
Matting For Erosion Control	Square Yard

7 **SECTION 1632**
8 **ROCK INLET SEDIMENT TRAP**

9 **1632-1 DESCRIPTION**

10 Construct, maintain and remove devices around catch basins and/or drop inlets to reduce
11 water velocity and contain sediment. Work includes furnishing all fence posts, hardware
12 cloth, hardware, stone and other materials, installing and maintaining the 1/4" hardware cloth.

13 The actual conditions which occur during the construction of the project will determine the
14 quantity of rock inlet sediment traps constructed. The quantity of inlet sediment traps may be
15 increased, decreased or eliminated entirely as directed. Such variations in quantity will not be
16 considered as alterations in the details of construction or a change in the character of the
17 work.

18 **1632-2 MATERIALS**

19 Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class A or Class B	1042-1

20 **(A) Steel Posts**

21 Provide steel posts in accordance with Subarticle 1605-2(A).

22 **(B) Wire Staples**

23 Provide No. 9 staple with at least 1 1/2" length or other approved attachment device.

24 **(C) 1/4 Inch Hardware Cloth**

25 Provide hardware cloth with 1/4" openings constructed from 24 gauge wire and with at
26 least 48" width as specified in ASTM A740.

27 **1632-3 CONSTRUCTION METHODS**

28 **(A) Type A**

29 Place structural stone, Class B, around the outside perimeter of the inlet structure with
30 approximately 2:1 side slopes and plate the upstream side with sediment control stone.

31 **(B) Type B**

32 Place structural stone, Class A, around the outside perimeter of the inlet structure with
33 approximately 2:1 side slopes and plate the upstream side with sediment control stone.

34 **(C) Type C**

35 Construct rock inlet sediment trap Type C devices as shown in the plans and at other
36 locations as directed. Attach hardware cloth to posts with wire staple or other acceptable
37 methods.

1 **1632-4 MAINTENANCE AND REMOVAL**

2 Maintain the rock inlet sediment trap, remove and dispose of silt accumulations at the inlet
3 sediment traps when necessary or as directed in accordance with Section 1630.

4 Remove rock inlet sediment traps as the project nears completion, or as directed. Dress the
5 area to blend with existing contours, seed and mulch the area in accordance with Section 1660.

6 **1632-5 MEASUREMENT AND PAYMENT**

7 Payment for rock inlet sediment traps will be made as follows:

8 *1/4 Inch Hardware Cloth* will be measured and paid in linear feet of hardware cloth,
9 measured in place from end post to end post at each separate installation completed and
10 accepted.

11 *Stone for Erosion Control, Class ____* will be measured and paid in accordance with
12 Section 1610.

13 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

14 *Silt Excavation* will be measured and paid in accordance with Section 1630.

15 Payment will be made under:

Pay Item	Pay Unit
1/4" Hardware Cloth	Linear Foot

16

SECTION 1633

17

TEMPORARY ROCK SILT CHECKS

18 **1633-1 DESCRIPTION**

19 Construct, maintain and remove devices placed in ditches, diversions or swales to reduce
20 water velocity and contain sediment.

21 The actual conditions which occur during the construction of the project will determine the
22 quantity of temporary rock silt checks constructed. The quantity of silt check dams may be
23 increased, decreased or eliminated entirely as directed. Such variations in quantity will not be
24 considered as alterations in the details of construction or a change in the character of the
25 work.

26 **1633-2 MATERIALS**

27 Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class A or Class B	1042-1

28 **1633-3 CONSTRUCTION METHODS**

29 **(A) Type A**

30 Place structural stone in the channel, ditch, diversion or swale with approximately 2:1
31 side slopes. Place sediment control stone, approximately 12" thick on the upstream side.

32 **(B) Type B**

33 Construct temporary rock silt check Type B devices as shown in the plans and at other
34 locations as directed.

35 **1633-4 MAINTENANCE AND REMOVAL**

36 Maintain the temporary rock silt checks, remove and dispose of silt accumulations at the silt
37 checks when so directed in accordance with Section 1630.

Section 1634

1 Remove temporary rock silt checks as the project nears completion. The actual time of
2 removal will be as directed. After removal of silt checks, dress the area to blend with existing
3 contours and seed and mulch the area in accordance with Section 1660.

4 **1633-5 MEASUREMENT AND PAYMENT**

5 Payment for temporary rock silt checks will be as follows:

6 *Stone for Erosion Control, Class ____* will be measured and paid in accordance with
7 Section 1610.

8 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

9 *Silt Excavation* will be measured and paid in accordance with Section 1630.

10 **SECTION 1634**
11 **TEMPORARY ROCK SEDIMENT DAMS**

12 **1634-1 DESCRIPTION**

13 Construct, maintain and remove devices placed in ditches, diversions, swales or drainage
14 turnouts to reduce water velocity and contain sediment.

15 The actual conditions which occur during the construction of the project will determine the
16 quantity of temporary rock sediment dams constructed. The quantity of rock sediment dams
17 may be increased, decreased or eliminated entirely as directed. Such variations in quantity
18 will not be considered as alterations in the details of construction or a change in the character
19 of the work.

20 **1634-2 MATERIALS**

21 Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class A or Class B	1042-1
Coir Fiber Mat	1060-14

22 **1634-3 CONSTRUCTION METHODS**

23 Install coir fiber baffles on the upstream side of each type of dam in accordance with
24 Section 1640 and as directed.

25 **(A) Type A**

26 Place structural stone in the channel, ditch diversion, swale or drainage turnouts with
27 2:1 side slope on the upstream side and 3:1 side slope on the downstream side. Plate the
28 upstream side with sediment control stone approximately 12" thick. Use a minimum
29 spacing of 15 ft and as directed for the coir fiber baffles.

30 Provide a weir section approximately 2/3 of the channel width and with an 8 ft maximum
31 height from the bottom of the channel. In the center of the device, place the weir section
32 approximately 12" lower than the sides of the device or the top of the channel, whichever
33 is lower.

34 **(B) Type B**

35 Place structural stone in the channel, ditch diversion, swale or drainage turnouts with
36 2:1 side slopes and plate the upstream side with sediment control stone approximately
37 12" thick.

1 In the center of the device, provide a weir section with a 4 ft minimum width constructed
 2 18" lower than the sides of the device or the top of the channel, whichever is lower.
 3 Construct the temporary rock sediment dam Type B with a 5 ft minimum thickness
 4 measured along the top of the dam structure.

5 Use earthen backfill material to extend dam width and create a larger sediment storage
 6 volume for the temporary rock sediment dam Type B where needed.

7 **1634-4 MAINTENANCE AND REMOVAL**

8 Maintain the temporary rock sediment dams, remove and dispose of silt accumulations at the
 9 sediment dams when so directed.

10 Remove temporary rock sediment dams as the project nears completion, or at such time as the
 11 Engineer deems the device to be no longer useful. The Engineer will direct the actual time of
 12 removal. Prepare seed bed, seed and mulch the area in accordance with Section 1660.

13 **1634-5 MEASUREMENT AND PAYMENT**

14 Payment for temporary rock sediment dams will be made as follows:

15 *Coir Fiber Baffle* will be measured and paid in accordance with Section 1640.

16 *Stone for Erosion Control, Class ____* will be measured and paid in accordance with
 17 Section 1610.

18 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

19 *Silt Excavation* will be measured and paid in accordance with Section 1630.

20 **SECTION 1635**

21 **ROCK PIPE INLET SEDIMENT TRAP**

22 **1635-1 DESCRIPTION**

23 Construct, maintain and remove devices placed around outside perimeters of pipe structures,
 24 to reduce water velocity and trap sediment.

25 The conditions which occur during the construction of the project will determine the quantity
 26 of temporary rock pipe inlet sediment traps to be constructed. The quantity of inlet sediment
 27 traps may be increased, decreased or eliminated entirely as directed. Such variations in
 28 quantity will not be considered as alterations in the details of construction or a change in the
 29 character of the work.

30 **1635-2 MATERIALS**

31 Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class A or Class B	1042-1

32 **1635-3 CONSTRUCTION METHODS**

33 **(A) Type A**

34 Construct rock pipe inlet sediment trap Type A devices at locations shown in the plans or
 35 as directed.

36 **(B) Type B**

37 Construct rock pipe inlet sediment trap Type B devices at locations shown in the plans or
 38 as directed.

Section 1636

1 **1635-4 MAINTENANCE AND REMOVAL**

2 Maintain the rock pipe inlet sediment traps, remove and dispose of silt accumulations at the
3 pipe inlet sediment traps as directed in accordance with Section 1630.

4 Remove rock pipe inlet sediment traps as the project nears completion, or as directed. Prepare
5 a seed bed to blend with existing contours and seed and mulch in accordance with
6 Section 1660.

7 **1635-5 MEASUREMENT AND PAYMENT**

8 Payment for temporary rock pipe inlet sediment traps will be as follows:

9 *Stone for Erosion Control, Class ____* will be measured and paid in accordance with
10 Section 1610.

11 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

12 *Silt Excavations* will be measured and paid in accordance with Section 1630.

13 **SECTION 1636**
14 **TEMPORARY STREAM CROSSING**

15 **1636-1 DESCRIPTION**

16 Construct and maintain culverted temporary stream crossings. Temporary stream crossings
17 are not shown in the plan sheets and shall be determined as directed.

18 The quantity of stream crossings to be installed will be affected by the actual conditions that
19 occur during the construction of the project. The quantity of stream crossings may be
20 increased, decreased or eliminated entirely as directed. Such variations in quantity will not be
21 considered as alterations in the details of construction or a change in the character of the
22 work.

23 **1636-2 MATERIALS**

24 Refer to Division 10.

Item	Section
Sediment Control Stone, No. 5 or 57	1005
Stone for Erosion Control, Class B	1042
Geotextile for Drainage, Type 2	1056

25 **1636-3 CONSTRUCTION METHODS**

26 Construct stream crossings according to *Roadway Standard Drawings* No. 1645.01 or as
27 directed.

28 The Contractor shall determine the diameter of pipe(s) that will pass the peak or bankfull
29 flow, whichever is less, from a 2-year peak storm, without overtopping. Place the geotextile
30 on natural ground, on streambanks and in streambed beneath the temporary pipe(s) and stone
31 according to the detail. Install Class B stone around the pipe(s), in the stream channel and on
32 the crossing road sideslopes. Place sediment control stone on top of Class B stone according
33 to *Roadway Standard Drawings* No. 1645.01.

34 **1636-4 MEASUREMENT AND PAYMENT**

35 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

36 *Stone for Erosion Control, Class ____* will be measured and paid in accordance with
37 Article 1610-4.

38 *Geotextile for Drainage* will be measured and paid in accordance with Article 876-4.

1 *Temporary Pipe for Stream Crossing* will be measured and paid at the contract unit price per
 2 linear foot of temporary pipe approved by the Engineer and measured in place from end to
 3 end.

4 Article 104-5, pertaining to revised contract prices, will not apply to this item. No revision in
 5 the contract unit price will be allowed because of any overrun or underrun.

6 Such price and payment will be full compensation for all work covered by this section,
 7 including, but not limited to, furnishing all materials, labor, equipment and incidentals
 8 necessary to construct the stream crossings.

9 Payment will be made under:

Pay Item	Pay Unit
Temporary Pipe for Stream Crossing	Linear Foot

10 **SECTION 1637**
 11 **RISER BASIN**

12 **1637-1 DESCRIPTION**

13 Construct, maintain and remove riser basin devices to reduce water velocity and contain
 14 sediment.

15 The actual conditions which occur during the construction of the project will determine the
 16 quantity of riser basin devices constructed. The quantity of riser basins may be increased,
 17 decreased or eliminated entirely as directed. Such variations in quantity will not be
 18 considered as alterations in the details of construction or a change in the character of the
 19 work.

20 **1637-2 MATERIALS**

21 Refer to Divisions 3 and 10.

Item	Section
C.S. Pipe Tee riser	1032-3(C)
Stone for Erosion Control, Class A or Class B	1042-1
Coir Fiber Mat	1060-14

22 Use a skimmer of solid Schedule 40 PVC pipe that meets the contract.

23 **1637-3 CONSTRUCTION METHODS**

24 Work includes constructing earth embankments and overflow spillways, and installing outlet
 25 pipe, tee-riser sections, trash racks, anti-flotation devices, coir fiber baffles, skimmer and
 26 stone energy dissipater in silt basins in accordance with *Roadway Standard Drawings*
 27 No. 1630.01 and 1630.02. Use either anti-flotation method shown in the plans.

28 Construct earth embankments with 2:1 side slopes with material meeting roadway
 29 embankment specifications in accordance with Section 1018. The maximum height of earth
 30 embankments is 12 ft. Compact embankment to at least 90% of AASHTO T 99 as modified
 31 by the Department and as directed. Excavate when required to provide minimum surface area
 32 and minimum storage volume area measured below the top of the principal spillway (top of
 33 the riser pipe).

34 Install a C.S. pipe tee riser as specified in the plans. Additional C.S. pipe may be required to
 35 obtain the required riser pipe height (crest elevation) as indicated in the plans. Construct
 36 a trash rack and an anti-flotation device on the riser pipe. Attach skimmer to riser pipe one
 37 foot above bottom elevation of basin.

38 Install coir fiber baffles in the basin in accordance with Section 1640 and as directed.

Section 1638

1 Construct an overflow spillway outlet, on natural ground, one foot above riser pipe. Plate
2 overflow spillway with erosion control stone Class B as specified in the plans.

3 Stabilize the embankment and surrounding areas with vegetation after installation. Construct
4 energy dissipater pad at the barrel pipe outlet with erosion control stone Class B in accordance
5 with the *Roadway Standard Drawings* No. 1630.01 and 1630.02.

6 **1637-4 MAINTENANCE AND REMOVAL**

7 Place a marker in the basin indicating the 50% volume level. Clean out riser basin when
8 sediment volume reaches 50% of the storage volume in accordance with Section 1630.

9 Remove riser basin devices as the project nears completion or as directed. Prepare a seed bed,
10 seed and mulch the area in accordance with Section 1660 after removal of the riser basin.

11 **1637-5 MEASUREMENT AND PAYMENT**

12 *C.S. Pipe Tee Riser, ___" Thick* will be measured and paid in units of each installed and
13 accepted. Such price shall include furnishing and installing any additional pipe required for
14 correct riser height, the trash rack and the anti-flotation device.

15 *Stone for Erosion Control, Class B* will be measured and paid in accordance with
16 Section 1610.

17 *Outlet Pipe* will be measured and paid in accordance with Section 310.

18 *Silt Excavation* will be measured and paid in accordance with Section 1630.

19 *Coir Fiber Baffle* will be measured and paid in accordance with Section 1640.

20 Payment will not be made for any work performed under this section that is solely for the
21 convenience of the Contractor or that is made necessary due to negligence of the Contractor.

22 Payment will be made under:

Pay Item	Pay Unit
___" x ___" x ___" C.S. Pipe Tee Riser, ___" Thick	Each

23

**SECTION 1638
STILLING BASIN**

24

25 **1638-1 DESCRIPTION**

26 Construct, maintain and remove earth embankments used to trap sediment from dewatering
27 construction sites during construction of drilled piers, footing excavation or culvert
28 construction. Work includes providing permeable stone drain, cleaning out, maintaining,
29 removing and disposing of the stilling basins and all components and reshaping the area.

30 The actual conditions that occur during the construction of the project will determine the
31 quantity of stilling basins constructed. The quantity of stilling basins may be increased,
32 decreased or eliminated entirely as directed. Such variations in quantity will not be
33 considered as alterations in the details of construction or a change in the character of the
34 work.

35 **1638-2 MATERIALS**

36 Use suitable excavated materials, as specified in Sections 225, 230 and 240, in the
37 construction of earth embankments for stilling basins, except where otherwise specified.

38 Refer to Division 10.

Item	Section
Stone for Erosion Control, Class A or Class B	1042-1
Sediment Control Stone, Standard Size No. 5 or 57	1005

Item	Section
Coir Fiber Mat	1060-14

1 **1638-3 CONSTRUCTION METHODS**

2 Construct stilling basins at the locations shown in the plans and at other locations as directed.

3 Construct earth embankment with a permeable stone drain in a rectangular form adjacent to
4 the stream and culvert following the applicable requirements of Section 235. The maximum
5 height allowed for earth dikes is 5 ft. Excavate below the natural ground for greater depths of
6 basins.

7 Install coir fiber baffles in accordance with Section 1640 and as directed.

8 **1638-4 MAINTENANCE AND REMOVAL**

9 Maintain the stilling basins, coir fiber baffles and remove and dispose of silt accumulations at
10 the stilling basins in accordance with Section 1630.

11 Remove the stilling basins as the project nears completion, or at such time the Engineer
12 deems the device to be no longer useful. Prepare a seed bed and seed and mulch the area
13 after removal of the stilling basin in accordance with Section 1660.

14 **1638-5 MEASUREMENT AND PAYMENT**

15 *Stilling Basin* quantities will be measured and paid in cubic yards, in place and computed by
16 the average-end-method for the actual number of cubic yards of basin capacity. The
17 measurements will be the internal measurements of the basin measured up to the top of the
18 permeable stone drain. Materials used to construct the basin that originates from another
19 payment item (i.e. unclassified excavation, borrow excavation) will not be deducted from the
20 volume of that original pay item.

21 *Stone for Erosion Control, Class ____* will be measured and paid in accordance with
22 Section 1610.

23 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

24 *Coir Fiber Baffle* will be measured and paid in accordance with Section 1640.

25 Payment will be made under:

Pay Item	Pay Unit
Stilling Basins	Cubic Yard

26

SECTION 1639

27

SPECIAL STILLING BASIN

28 **1639-1 DESCRIPTION**

29 Furnish, place and remove special stilling basins as directed. The special stilling basin can be
30 used to filter pumped water during construction of drilled piers, footing excavation or culvert
31 construction. The special stilling basin can be used for sediment storage at the outlet of
32 temporary slope drain pipes.

33 **1639-2 MATERIALS**

34 Refer to Division 10.

Item	Section
Geotextile for Drainage, Type 2	1056
Sediment Control Stone, Standard Size No. 5 or 57	1005

35 Use geotextile and sediment control stone that is clean and without debris.

Section 1639

- 1 Use a special stilling basin that is a water permeable geotextile bag that traps sand, silt and
2 fines as sediment-laden water is pumped into it, or as runoff flows into it through the
3 temporary slope drain pipe(s).
- 4 Provide special stilling basin of a bag constructed to a minimum size of 10 ft x 15 ft made
5 from a nonwoven geotextile. Provide a sewn-in 8" (maximum) spout for receiving pump
6 discharge. Sew the bag seams with a double needle machine using a high strength thread.
7 The seams shall have a minimum wide width strength of 60 lb/in in accordance with
8 ASTM D4884.
- 9 Construct the bag with a geotextile stabilized to provide resistance to UV degradation meeting
10 Table 1639-1.

Property	Minimum Requirement	Test Method
Weight	8.0 oz/yd	ASTM D3776
Grab tensile	200.0 lb	ASTM D4632
Puncture	130.0 lb	ASTM D4833
Flow rate	80.0 gal/min/sf	ASTM D4491
Permittivity	1.2 1/sec	ASTM D4491
UV Resistance	70.0%	ASTM D4355

11 **1639-3 CONSTRUCTION METHODS**

12 Install the special stilling basin(s), geotextile and stone in accordance with *Roadway Standard*
13 *Drawings* No. 1630.06 and at locations in the plans and as directed. Place the special stilling
14 basin(s) on level ground.

15 Construct the special stilling basin(s) such that it is portable and can be used adjacent to each
16 drilled pier, footing and/or culvert, as required by the project commitments. Temporary slope
17 drain pipe(s) or pump discharge hoses will be attached to the special stilling basin(s) to divert
18 runoff or pumped effluent directly into the special stilling basin(s). The special stilling basin
19 may be cut to allow slope drain pipe to be inserted if needed and tied off tightly. The
20 remaining sleeve or spout of the bag, if present, may be used to connect more than one special
21 stilling basin in series as directed. If not used in this manner, the sleeve shall be tied off
22 tightly to allow the bag to contain the effluent and force it to filter through the sides of the
23 special stilling basin. Place the special stilling basin(s) so the incoming runoff or pumped
24 effluent flows into and through it without causing erosion to adjacent slopes or streambanks.
25 In areas of turbidity and water quality concern, place the special stilling basin(s) up grade and
26 direct its runoff into a sediment control measure before being allowed to discharge into
27 jurisdictional waters.

28 Replace and dispose of the special stilling basin(s) when it is 3/4 full of sediment or when it is
29 impractical for the bag to filter the sediment out at a reasonable flow rate. Prior approval
30 from the Engineer shall be received before removal and replacement.

31 Provide a sufficient quantity of bags to contain silt from pumped effluent during construction
32 of drilled piers, footing excavation and culvert construction. A sufficient quantity of special
33 stilling basins shall be provided to contain sediment from temporary slope drain runoff.

34 **1639-4 MEASUREMENT AND PAYMENT**

35 *Special Stilling Basin* will be measured and paid as the actual number of bags used during
36 temporary slope drain installation, drilled pier construction, footing excavation or culvert
37 construction as specified and accepted.

38 *Geotextile for Drainage* will be measured and paid in accordance with Article 876-4.

39 *Sediment Control Stone* will be measured and paid in accordance with Section 1610.

1 Such price and payment will be full compensation for all work covered by this section,
 2 including but not limited to, furnishing all materials, placing and maintaining the special
 3 stilling basin(s) and removal and disposal of silt accumulations and bag.

4 Payment will be made under:

Pay Item	Pay Unit
Special Stilling Basins	Each

5 **SECTION 1640**
 6 **COIR FIBER BAFFLE**

7 **1640-1 DESCRIPTION**

8 Furnish material, install and maintain coir fiber baffles according to the details in the plans or
 9 in locations as directed. Install coir fiber baffles in silt basins and sediment dams at drainage
 10 outlets. Work includes providing all materials, placing, securing, excavating and backfilling
 11 of coir fiber baffles.

12 **1640-2 MATERIALS**

13 **(A) Coir Fiber Mat**

14 Provide matting to meet Table 1640-1.

TABLE 1640-1	
COIR FIBER MAT PROPERTIES	
Property	Requirement
Composition	100% coconut fiber (coir) twine woven into high strength matrix
Thickness	0.30" minimum
Tensile Strength	1348 x 626 lb/ft minimum
Elongation	34% x 38% maximum
Flexibility (mg-cm)	65030 x 29590
Flow Velocity	Observed 11 ft/sec
Weight	20 oz/sy
Size	6.6 x 164 ft (120 sy)
"C" Factor	0.002
Open Area (measured)	50%

15 **(B) Staples**

16 Provide staples made of 0.125 in. diameter new steel wire formed into a U-shape not less
 17 than 12" in length with a throat of 1" in width.

18 **(C) Posts**

19 Provide steel posts at least 5 ft in length, approximately 1 3/8" wide measured parallel to
 20 the fence and have a minimum weight of 1.25 lb/ft of length. Equip the post with
 21 an anchor plate having a minimum area of 14.0 sq.in. and of the self-fastener angle steel
 22 type to have a means of retaining wire and coir fiber mat in the desired position without
 23 displacement.

24 **(D) Wire**

25 Provide 9-gauge high tension wire strand of variable lengths.

26 **(E) Attachment Device**

27 Provide No. 9 staple with at least 1 1/2" length or other approved attachment device.

Section 1650

1 1640-3 CONSTRUCTION METHODS

2 Place the coir fiber baffles immediately upon construction of sediment dams and basins.
3 Install 3 baffles in basins with a spacing of 1/4 the basin length and according to the detail
4 sheets. Install 2 coir fiber baffles in basins less than 20 ft in length with a spacing of 1/3 the
5 basin length.

6 Place steel posts at a depth of 2 ft below the basin surface, with spacing of no more than 4 ft.
7 The top height of the coir fiber baffles shall not be below the elevation of the emergency
8 spillway base of dams and basins. Attach a 9-gauge high-tension wire strand to the steel posts
9 at a height of 3 ft with plastic ties or wire fasteners. Install a steel post into side of the basin at
10 a variable depth and a height of 3 ft from the bottom of the basin to anchor coir fiber mat.
11 Secure anchor post to the upright steel post in basin with wire fasteners.

12 Drape the coir fiber mat over the wire strand with at least 3 ft of material on each side of the
13 strand. Secure the coir fiber mat to the posts and wire strand with wire staples or other
14 acceptable methods. Place staples across the matting at ends and junctions approximately one
15 foot apart at the bottom and side slopes of basin. Overlap matting at least 6" where 2 or more
16 widths of matting are installed side by side. Refer to details in the plans. The Engineer may
17 require adjustments in the stapling requirements to fit individual site conditions.

18 1640-4 MEASUREMENT AND PAYMENT

19 *Coir Fiber Baffles* will be measured and paid as the actual number of linear feet of coir fiber
20 baffles which are installed and accepted. Such price and payment will be full compensation
21 for all work covered by this section, including, but not limited to, furnishing all materials,
22 labor, equipment and incidentals necessary to install the coir fiber baffles.

23 Payment will be made under:

Pay Item	Pay Unit
Coir Fiber Baffles	Linear Foot

**SECTION 1650
WOODED AREA CLEANUP**

26 1650-1 DESCRIPTION

27 Remove and satisfactorily dispose of debris and of dead, partially dead or broken vegetation
28 from wooded areas of the right of way outside clearing limits and from other areas outside
29 construction limits on which seeding and mulching is not to be performed. Work includes
30 treating stumps with herbicide and repairing any damage to vegetation.

31 Cutover timberland, reforested areas or thickets of young native volunteer vegetation will be
32 considered to be wooded areas.

33 1650-2 MATERIALS

34 Refer to Division 10.

Item	Section
Herbicide	1060-13

35 1650-3 CONSTRUCTION METHODS

36 Remove all logs, stumps, snags, loose roots, down timber, slabs, tree laps, lumber, dead or
37 partially dead trees, broken trees or brush, dead brush, sawdust piles, discarded fences, leaf
38 piles, brick, tile masonry and other debris from the cleanup areas. Cut, all dead trees, stumps,
39 snags, broken or partially dead trees and brush, flush with the ground. Remove vegetation
40 which dies between initial cleanup and completion of the project before final acceptance.
41 Hand raking of areas or removal of a normal leaf layer is not required unless stated in the
42 contract.

1 Treat partially dead stumps or broken vegetation with a herbicide immediately after cutting.
 2 Use the herbicide and the method and rate of application, specified in the contract. Follow all
 3 applicable instructions, warnings and safety precautions stated on the manufacturer's label,
 4 and comply with all laws and regulations governing herbicides that are in effect at the time of
 5 use.

6 Dispose of all material cleaned up under this item in accordance with the applicable
 7 requirements of Article 200-5 and Article 802-2.

8 **1650-4 DAMAGE TO REMAINING VEGETATION**

9 Conduct operations so as to prevent injury to trees, shrubs or other types of vegetation that are
 10 to remain growing and to prevent damage to adjacent property.

11 Remove broken branches and rough edges of scarred trees or shrubs. Prune and shape these
 12 areas in accordance with the International Society of Arboriculture pruning techniques. Cut
 13 and dispose of any plants that are damaged beyond their value for landscape purposes and
 14 seed and mulch vegetation that is damaged by the Contractor at no cost to the Department
 15 when so directed.

16 **1650-5 MEASUREMENT AND PAYMENT**

17 *Wooded Area Cleanup* will be measured and paid in acres, measured horizontally, completed
 18 and accepted.

19 Payment will be made under:

Pay Item	Pay Unit
Wooded Area Cleanup	Acre

20 **SECTION 1651**
 21 **SELECTIVE VEGETATION REMOVAL**

22 **1651-1 DESCRIPTION**

23 Remove selected living trees and undesirable living undergrowth from areas of the right of
 24 way outside clearing limits in accordance with these Specifications. Work includes treating
 25 stumps with herbicide and repairing any damage to vegetation.

26 **1651-2 MATERIALS**

27 Refer to Division 10.

Item	Section
Herbicide	1060-13

28 **1651-3 CONSTRUCTION METHODS**

29 **(A) Trees**

30 Remove trees shown in the plans or designated. Measure all tree diameter sizes at
 31 a height of 4.5 ft above the ground.

32 **(B) Undergrowth**

33 Remove all undergrowth from areas shown in the plans, described in the Specifications or
 34 designated, except for those plants designated to be preserved. All plants less than 4" in
 35 diameter, measured at a height of 4.5 ft above the ground shall be classified as
 36 undergrowth.

Section 1660

(C) General

Treat stumps with a herbicide immediately after cutting to prevent sprouting. Use the herbicide and the method and rate of application specified in the Specifications. Follow all applicable instructions, warnings and safety precautions stated on the manufacturer's label, and comply with all laws and regulations governing herbicides that are in effect at the time of use.

When work is performed properly in accordance with these Specifications, no subsequent re-cutting of sprouts or seedling growth will be required.

Dispose of all trees and undergrowth cut in accordance with Article 200-5.

1651-4 DAMAGE TO REMAINING VEGETATION

Conduct operations so as to prevent injury to trees, shrubs or other types of vegetation that are to remain growing, and also to prevent damage to adjacent property.

Remove broken branches and rough edges of scarred trees or shrubs. Shape and make smooth these areas in accordance with generally accepted horticultural practice. Cut and dispose of any plants that are damaged beyond their value for landscape purposes and seed and mulch vegetation that is damaged by the Contractor at no cost to the Department.

1651-5 MEASUREMENT AND PAYMENT

Selective Tree Removal ___" will be measured and paid in units of each. Each tree removed will be paid at the contract unit price for the pay item size applicable to the actual tree diameter, measured at a height of 4.5 ft above the ground, as indicated in Table 1651-1.

TABLE 1651-1 SELECT TREE REMOVAL PAY ITEM SIZES	
Pay Item Size	Actual Tree Diameter
6 inch	4 inches up to 8 inches
10 inch	8 inches up to 12 inches
15 inch	12 inches up to 18 inches
18 inches	18 inches and over

Selective Undergrowth Removal will be measured and paid in acres, measured horizontally, completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Selective Tree Removal, 6"	Each
Selective Tree Removal, 10"	Each
Selective Tree Removal, 15"	Each
Selective Tree Removal, 18"	Each
Selective Undergrowth Removal	Acre

**SECTION 1660
SEEDING AND MULCHING**

1660-1 DESCRIPTION

Prepare seedbed; furnish, place and incorporate limestone, fertilizer and seed; compact seedbed; furnish, place and secure mulch; mow; and perform other operations necessary for the permanent establishment of vegetation from seed on shoulders, slopes, ditches or other roadside areas.

Perform seeding and mulching on all earth areas disturbed by construction and on portions of areas seeded under previous contracts as directed where there is unsatisfactory vegetative cover.

1 Adapt operations to variations in weather or soil conditions as necessary for the successful
2 establishment and growth of the grasses or legumes.

3 Preserve the required line, grade and cross section of the area treated.

4 The actual conditions which occur during the construction of the project will determine the
5 quantity of mowing. The quantity of mowing may be increased, decreased or eliminated
6 entirely as directed. Such variations in quantity will not be considered as alterations in the
7 details of construction or a change in the character of the work.

8 **1660-2 MATERIALS**

9 Refer to Division 10.

Item	Section
Fertilizer	1060-2
Limestone	1060-3
Seed	1060-4
Mulch for Erosion Control	1060-5

10 Use undiluted emulsified asphalt for tacking material.

11 The analysis of fertilizer and the kinds of seed will be as stated in the contract.

12 **1660-3 COORDINATION WITH GRADING OPERATIONS**

13 Perform seeding and mulching operations on a section by section basis immediately upon
14 completion of earthwork sections in accordance with Article 225-2.

15 When grading operations have been suspended, and seeding and mulching has been
16 performed on areas where work has been suspended, include in the work of seeding and
17 mulching of the adjacent sections any necessary overlapping of operations on previously
18 established vegetative cover.

19 When the Contractor fails or neglects to coordinate grading with seeding and mulching
20 operations and to pursue diligently the control of erosion and siltation, the Engineer may
21 suspend the Contractor's grading operations until such time as the work is coordinated in
22 a manner acceptable to the Engineer. Such suspension will be in accordance with
23 Article 108-7.

24 **1660-4 SEEDBED PREPARATION**

25 Cut and satisfactorily dispose of weeds or other unacceptable growth on the areas to be
26 seeded. Shape and smooth uneven and rough areas outside of the graded section, such as crop
27 rows, farm contours, ditches and ditch spoil banks, fence line and hedgerow soil
28 accumulations and other minor irregularities which cannot be obliterated by normal seedbed
29 preparation operations, to provide for more effective seeding and for ease of subsequent
30 mowing operations.

31 Scarify or otherwise loosen the soil to a depth of not less than 5" except as otherwise provided
32 below or otherwise directed. Break clods and work the top 2" to 3" of soil into an acceptable
33 seedbed by the use of soil pulverizers, drags or harrows; or by other approved methods.
34 Remove all rock and debris 3" or larger on median, shoulder and ditch cut or fill slopes which
35 are 3:1 or flatter, before the application of seed and fertilizer. Remove rock 6" and larger
36 displaced during seeding operations.

37 Scarify, groove, trench or puncture all slope surfaces. The depth of preparation and the
38 degree of smoothness of the seedbed may be reduced on cut slopes that are 2:1 and steeper, as
39 permitted by the Engineer.

Section 1660

1 On cut slopes that are either 2:1 or steeper, the Engineer may permit the preparation of
2 a partial or complete seedbed during the grading of the slope. If at the time of seeding and
3 mulching operations such preparation is still in a condition acceptable to the Engineer,
4 additional seedbed preparation may be reduced or eliminated.

5 Limit seedbed preparation to within 2 ft of the edge of any pavement to a depth of 2" to 3".

6 Do not prepare seedbed when the soil is frozen, extremely wet or when the Engineer
7 determines that it is an otherwise unfavorable working condition.

8 **1660-5 APPLYING AND COVERING LIMESTONE, FERTILIZER AND SEED**

9 **(A) General**

10 The contract will state the seasonal limitation for seeding operations; the kinds of grades
11 of fertilizers; the kinds of seed; and the rates of application of limestone, fertilizer and
12 seed.

13 Obtain approval from the Engineer before using equipment for the application, covering
14 or compaction of limestone, fertilizer and seed. Approval may be revoked at any time if
15 equipment is not maintained in satisfactory working condition, or if the equipment
16 operation damages the seed.

17 Apply limestone, fertilizer and seed within 24 hours after completion of seedbed
18 preparation unless otherwise permitted by the Engineer. When the Engineer determines
19 that weather and soil conditions are unfavorable, do not distribute any limestone or
20 fertilizer and do not sow any seed.

21 Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic
22 control devices or any other appurtenances during the application of fertilizer. Provide
23 adequate covering or change methods of application as required to avoid such damage.
24 Repair any damage that occurs, including any cleaning that may be necessary.

25 **(B) Limestone and Fertilizer**

26 Limestone may be applied as a part of the seedbed preparation, provided it is
27 immediately worked into the soil. If not so applied, distribute limestone and fertilizer
28 uniformly over the prepared seedbed at the specified rate of application and then harrow,
29 rake or otherwise thoroughly work or mix into the seedbed.

30 **(C) Seed**

31 Distribute seed uniformly over the seedbed at the required rate of application, and
32 immediately harrow, drag, rake or otherwise work so as to cover the seed with a layer of
33 soil. Cover to a depth as directed by the Engineer. If 2 kinds of seed are to be used
34 which require different depths of covering, sow separately.

35 When a combination seed and fertilizer drill is used, drill fertilizer with seed after
36 applying and incorporating limestone into the soil. If using two kinds of seed requiring
37 different depth of cover, the seed requiring the lighter cover may be sown broadcast or
38 with a special attachment to the drill, or drilled lightly following the initial drilling
39 operation.

40 When using a hydraulic seeder for application of seed and fertilizer, do not allow the seed
41 to remain in water containing fertilizer for more than 30 minutes before application
42 unless otherwise permitted.

43 Compact the seedbed immediately after seed has been properly covered in the manner
44 and degree approved by the Engineer.

(D) Modifications

When adverse seeding conditions are encountered due to steepness of slope, height of slope or soil conditions, the Engineer may direct or permit that modifications be made in the above requirements which pertain to incorporating limestone into the seedbed; covering limestone, seed and fertilizer; and compaction of the seedbed.

Such modifications may include but not be limited to the following:

- (1) The incorporation of limestone into the seedbed may be omitted as follows:
 - (a) On cut slopes steeper than 2:1;
 - (b) On 2:1 cut slopes when a seedbed has been prepared during the excavation of the cut and is still in an acceptable condition; or
 - (c) On areas of slopes where the surface of the area is too rocky to permit the incorporation of the limestone.
- (2) The rates of application of limestone, fertilizer and seed on slopes 2:1 or steeper or on rocky surfaces may be reduced or eliminated.
- (3) Compaction after seeding may be reduced or eliminated on slopes 2:1 or steeper, on rocky surfaces or on other areas where soil conditions would make compaction undesirable.

1660-6 MULCHING**(A) General**

Mulch all seeded areas unless otherwise indicated in the contract or directed by the Engineer.

Use grain straw as mulch at any time of the year. If permission to use material other than grain straw is requested and the use of such material is approved by the Engineer, the seasonal limitations, the methods and rates of application, the type of binding material or other conditions governing the use of such material will be established by the Engineer at the time of approval.

(B) Applying Mulch

Apply mulch within 24 hours after completion of seeding unless otherwise permitted. Exercise care to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.

Spread mulch uniformly by hand or by approved mechanical spreaders or blowers which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion and conserve soil moisture.

(C) Holding Mulch

Hold mulch in place by applying a sufficient amount of undiluted emulsified asphalt or other approved binding material. The Engineer will approve the rate and method of application of binding material. Apply the binding material directly with the mulch or immediately following the mulch application.

Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic control devices or any other appurtenances during the application of asphalt binding material. Provide adequate covering or change methods of application as required to avoid such damage. Repair any damage that occurs, including any cleaning that may be necessary.

Section 1660

1 Take sufficient precautions to prevent mulch from entering drainage structures through
2 displacement by wind, water or other causes and promptly remove any blockage to
3 drainage facilities which may occur.

4 **1660-7 MAINTENANCE OF SEEDING AND MULCHING**

5 Maintain areas where seeding and mulching have been performed in a satisfactory condition
6 until final acceptance of the project.

7 Mow at the location and times as directed.

8 Correct areas of damage or failure due to any cause by repairing or completely reworking as
9 directed.

10 Repair in accordance with Section 1661 where extensive seedbed preparation is unnecessary.

11 Rework seeding and mulching in accordance with this section where correction requires
12 extensive seedbed preparation, or where earthwork repairs or complete reshaping are
13 necessary.

14 As an exception to the above, repair areas of damage or failure resulting either from
15 negligence on the part of the Contractor in performing subsequent construction operations or
16 from not taking adequate precautions to control erosion and siltation as required throughout
17 the various sections of the Specifications, at no cost to the Department.

18 **1660-8 MEASUREMENT AND PAYMENT**

19 *Seeding and Mulching* will be measured and paid in acres, measured along the surface of the
20 ground completed and accepted. No direct payment will be made for furnishing and applying
21 the limestone and fertilizer as such work and materials will be incidental to the work covered
22 by *Seeding and Mulching*.

23 *Mowing* will be measured and paid in acres measured along the surface of the ground mowed
24 as directed. Where an area has been mowed more than once at the direction of the Engineer,
25 separate measurement will be made each time the area is mowed.

26 Corrective work will be compensated where seeding and mulching has been damaged or has
27 failed to establish a satisfactory stand of vegetation.

28 Where correction can be made without extensive seedbed preparation, the work will be paid
29 in accordance with Section 1661 for *Seed for Repair Seeding* and *Fertilizer for Repair*
30 *Seeding*.

31 Where earthwork and seeding and mulching has been damaged to the extent that earthwork
32 repairs or complete reshaping are necessary, the Contractor will be paid at the contract unit
33 price for the excavated material required for repairs to the damaged earthwork, and at the
34 contract unit price for *Seeding and Mulching* for correcting the damaged seeding and
35 mulching.

36 As an exception to the above, repair, at no cost to the Department, any damage to earthwork
37 or seeded and mulched areas which is due to carelessness or neglect on the part of the
38 Contractor.

39 Payment will be made under:

Pay Item	Pay Unit
Seeding and Mulching	Acre
Mowing	Acre

**SECTION 1661
REPAIR SEEDING**

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1661-1 DESCRIPTION

Repair areas previously seeded and mulched in accordance with Section 1660 but damaged or failed to successfully establish a stand of vegetation. This work does not include repair seeding made necessary by negligence on the part of the Contractor as described in Article 1660-7, nor does it include repairs to temporary seeding constructed in accordance with Section 1620.

Repair damage or failure in accordance with this section where correction can be made without extensive seedbed preparation.

Where correction will require extensive seedbed preparation, or where earthwork repairs or complete reshaping are necessary, repair in accordance with Section 1660.

Repair seeding includes minor seedbed preparation; the furnishing, placing and covering of fertilizer and seed; and mulch as required, all in accordance with these Specifications.

Perform repair seeding promptly at the locations and times as directed.

The actual conditions which occur during the construction of the project will determine the quantity of seed or fertilizer used. The quantity of seed or fertilizer may be increased, decreased or eliminated entirely at the discretion of the Engineer. Such variation in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1661-2 MATERIALS

Refer to Division 10.

Item	Section
Fertilizer	1060-2
Seed	1060-4
Mulch for Erosion Control	1060-5

The analysis of fertilizer and the kinds of seed shall be as stated in the contract.

1661-3 SEEDBED PREPARATION

Seedbed preparation will be required unless otherwise permitted.

A seedbed preparation as extensive as that performed for the original seeding and mulching will not be required. The degree of preparation shall be sufficient to retain the seed against displacement by wind, rain or surface runoff, and be acceptable to the Engineer. The acceptable degree of seedbed preparation will depend on the location, soil conditions and drainage conditions at the site.

1661-4 APPLICATION OF FERTILIZER, SEED AND MULCH

The analysis of fertilizer, the kinds of seed and the rates of application of seed and fertilizer is the same as specified in the project special provision for seeding and mulching, unless otherwise directed, but in no case will the total rate of seed and fertilizer vary more or less than 25% of that specified for seeding and mulching.

Do not distribute fertilizer or sow seed when the Engineer determines that conditions are unfavorable for such operations.

Cover fertilizer and seed and secure mulch in place to prevent displacement by wind, rain or surface runoff.

Article 1660-5 will be applicable to the approval of equipment and the protection of traffic, structures, guardrails, traffic control devices and other appurtenances.

Section 1662

1 **1661-5 MEASUREMENT AND PAYMENT**

2 *Seed for Repair Seeding* will be measured and paid in pounds. The weight of seed will be
3 determined by bag count of standard weight bags or by weighing the seed. No direct payment
4 will be made for furnishing and applying mulch and all materials used to hold mulch in place,
5 as such work and materials will be incidental to the work covered by *Seed for Repair Seeding*.

6 *Fertilizer for Repair Seeding* will be measured and paid in tons. The weight of dry fertilizer
7 will be determined by bag count of standard weight bags, or by weighing the fertilizer in
8 trucks on certified platform scales or other certified weighing devices.

9 Payment will be made under:

Pay Item	Pay Unit
Seed for Repair Seeding	Pound
Fertilizer for Repair Seeding	Ton

10 **SECTION 1662**
11 **SUPPLEMENTAL SEEDING**

12 **1662-1 DESCRIPTION**

13 Apply additional seed to areas which have been previously seeded with permanent seed but
14 on which there is an unsatisfactory cover of vegetation.

15 This work is only to provide an additional amount of seed to areas that have an insufficient
16 stand of vegetation but which are too well established to require repair seeding. Work
17 covered by this provision does not include seedbed preparation, fertilizer or mulch.

18 Perform supplemental seeding promptly at the locations and times as directed.

19 The actual conditions which occur during the construction of the project will determine the
20 quantity of seed used. The quantity of seed may be increased, decreased or eliminated
21 entirely as directed. Such variation in quantity will not be considered as alterations in the
22 details of construction or a change in the character of the work.

23 **1662-2 MATERIALS**

24 Refer to Division 10.

Item	Section
Seed	1060-4

25 Use seeds as stated in the contract.

26 **1662-3 APPLICATION**

27 Seedbed preparation will not be required.

28 The contract will state the kinds and rates of application of seed. Sow no seed when the
29 Engineer determines that conditions are unfavorable.

30 Article 1660-5 will be applicable to the approval of equipment; and the protection of traffic,
31 traffic control devices and other appurtenances.

32 **1662-4 MEASUREMENT AND PAYMENT**

33 *Seed for Supplemental Seeding* will be measured and paid in pounds. The weight of seed will
34 be determined by bag count of standard weight bags or by weighing the seed.

35 Payment will be made under:

Pay Item	Pay Unit
Seed for Supplemental Seeding	Pound

SECTION 1664 SODDING

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3 **1664-1 DESCRIPTION**

4 Prepare soil, furnish and place limestone, fertilizer, sod and water; and other operations
5 necessary for the permanent establishment of vegetation from sod on shoulders, slopes,
6 ditches or other roadside areas.

7 Adapt operations to variations in weather and soil conditions so as to assure the successful
8 establishment and growth of grasses.

9 Preserve the required line, grade and cross section of the area treated.

10 The actual conditions which occur during the construction of the project will determine the
11 quantity of water used and mowing required. The quantity of water or mowing may be
12 increased, decreased or eliminated entirely at the direction of the Engineer. Such variations in
13 quantity will not be considered alterations in the details of construction or a change in the
14 character of the work.

15 **1664-2 MATERIALS**

16 Refer to Division 10.

Item	Section
Fertilizer	1060-2
Limestone	1060-3
Sod	1060-7
Water	1060-9

17 The contract will state the analysis of fertilizer and the kinds of sod.

18 **1664-3 SODDING**

19 **(A) Handling and Storing Sod**

20 Exercise extreme care during all operations of loading, transporting, unloading, storing,
21 placing, tamping and staking sod, to prevent breaking the sod sections and to prevent the
22 sod from drying out. Any sod that is torn, broken or too dry will be rejected. Torn or
23 broken sod, if kept moist, may be used for filling unavoidable small gaps in sod cover as
24 permitted.

25 Place sod on the designated areas within 48 hours after being cut unless otherwise
26 directed.

27 **(B) Soil Preparation**

28 Remove litter and other debris. Mow and satisfactorily dispose of weeds or other
29 unacceptable growth on the areas to be sodded.

30 Bring the area to be sodded to a firm uniform surface at such elevation that the surface of
31 the complete sodding conforms to the finished grade and cross section as shown in the
32 plans.

33 Scarify or otherwise loosen soil to a depth of not less than 5". Break clods and work the
34 top 2" to 3" of soil into an acceptable soil bed by using soil pulverizers, drags or harrows.

35 Place limestone and fertilizer before placing the sod. The contract will state the kind and
36 grade of fertilizer, and the rates of application of limestone and fertilizer. Distribute the
37 limestone and fertilizer uniformly over the area and thoroughly mix in the top 5" of the
38 soil by discing, harrowing or other approved methods.

39 Prepare the area by harrowing, dragging, raking or other approved methods to give
40 a lawn type finish. Remove all trash, debris and stones larger than 1 1/2" in diameter or

Section 1664

1 other obstructions that could interfere with the placing of the sod. Moisten the finished
2 surface with water before placing the sod.

3 (C) Placing Sod

4 The contract will state the seasonal limitations for sodding and the kind of sod to use.

5 Sod handling and placement will be a continuous process of cutting, transporting and
6 installing without appreciable delays. Install sod within 48 hours after being cut and
7 water immediately after installation.

8 Place sod firmly and carefully by hand within 24 hours after soil preparation is completed
9 and accepted by the Engineer. Pack each piece of sod tightly against the edge of adjacent
10 pieces so that the fewest possible gaps will be left between the pieces. Close unavoidable
11 gaps with small pieces of sod.

12 When placing sod on a slope, begin at either the top or the toe of the slope. Place sod
13 with the long edge horizontal and with staggered vertical joints. Turn the edge of the sod
14 slightly into the ground at the top of a slope and place a layer of earth over it and compact
15 so as to divert the surface water over and onto the top of the sod.

16 Stake sod in place by driving stakes flush with the sod, on all slopes 2:1 or steeper, in
17 drainage channels, on other areas shown in the plans, and on any areas that are in such
18 condition that there is danger of sod slipping. Perform staking concurrently with sod
19 placement and before tamping with sound wooden stakes which are approximately one
20 inch square or one inch in diameter and not less than 12" in length. Place enough stakes
21 to prevent slipping or displacement of the sod. Drive stakes perpendicular to the slope.
22 Where backfill is necessary on cut slopes to obtain a uniform sodding area, provide
23 stakes of sufficient length to reach at least 3" into the solid earth underneath the backfill.

24 On all other areas, use metal staples in place of wooden stakes. The metal staples should
25 be 12" long, made of 11 gauge new steel wire so as not to bend when pinned or driven
26 through the sod. Shorter staples may be used with the approval of the Engineer.

27 Place, stake and staple the sod where necessary, then tamp or roll carefully and firmly by
28 acceptable means. If rolled, roller shall weigh 150 lb/ft of roller width. Take extreme
29 care to prevent the installed sod from being torn or displaced.

30 Do not place sod when the atmospheric temperature is below 32°F. Do not use frozen
31 sod or place on frozen soil.

32 (D) Watering Sod

33 Water carefully and thoroughly after sod has been placed and tamped. Perform watering
34 as directed until final acceptance. Application of water may be made by the use of
35 hydraulic seeding equipment, farm type irrigation equipment or by other acceptable
36 means.

37 1664-4 MAINTENANCE

38 Maintain sod in a satisfactory and live condition until final acceptance of the project.
39 Maintenance includes watering and mowing at the locations and times as directed.

40 1664-5 MEASUREMENT AND PAYMENT

41 *Sodding* will be measured and paid in square yards, measured along the surface of the ground
42 completed and accepted. No direct payment will be made for mowing the sodding areas
43 before soil preparation as such work will be incidental to sodding. No direct payment will be
44 made for furnishing and applying limestone and fertilizer, as such will be incidental to the
45 work covered by sodding.

46 *Water* will be measured and paid in 1,000 gallon units. Measurement of water will be made
47 by means of an approved metering device at the source of supply, or by determining the

1 volumetric capacity of tank trucks used to deliver water to the project and recording the
2 number of loads delivered by each truck.

3 *Mowing* will be measured and paid in accordance with Section 1660.

4 The above prices and payment will be full compensation for all work covered by this section.

5 Payment will be made under:

Pay Item	Pay Unit
Sodding	Square Yard
Water	1,000 Gallons

6

SECTION 1665

7

FERTILIZER TOPDRESSING

8

1665-1 DESCRIPTION

9 Furnish and uniformly distribute fertilizer as a topdressing to areas on which seeding and
10 mulching, sprigging or sodding are completed and a vegetative cover is established. Top
11 dress previously seeded, sprigged or sodded areas under other contracts when so stated in the
12 contract or where so directed.

13 The actual conditions that occur during the construction of the project will determine the
14 quantity of fertilizer topdressing used. In the event that a vegetative cover has not had
15 sufficient time to develop to a size suitable for topdressing before completion of the project,
16 the work of fertilizer topdressing will be decreased or eliminated entirely. Where the use of
17 additional fertilizer topdressing would be beneficial to the establishment of grasses or
18 legumes, the work of fertilizer topdressing will be increased. The quantity of fertilizer
19 topdressing may be increased, decreased or eliminated entirely as directed. Such variations in
20 quantity will not be considered as alterations in the details of construction or a change in the
21 character of work.

22 1665-2 MATERIALS

23 Use fertilizer containing no urea for topdressing.

24 Refer to Division 10.

Item	Section
Fertilizer	1060-2

25 The analysis of fertilizer shall be as stated in the contract.

26 1665-3 APPLICATION

27 Apply fertilizer topdressing at the locations and times as directed, regardless of whether or not
28 other seeding, sprigging or sodding operations are underway at the time.

29 The contract will state the rate of application and analysis of fertilizer. Distribute fertilizer
30 uniformly without any type of soil disturbance.

31 Refer to the contract for the approval of equipment and the protection of traffic, structures,
32 guardrails, traffic control devices and other appurtenances.

33 1665-4 MEASUREMENT AND PAYMENT

34 *Fertilizer Topdressing* will be measured and be paid in tons. The weight of dry fertilizer will
35 be determined by bag count of standard weight bags or by weighing the fertilizer in trucks on
36 certified platform scales or other certified weighing devices.

37 In the event that an alternative analysis of fertilizer topdressing is approved and used, it will
38 be in an equivalent number of tons of fertilizer, of the specified analysis, based on nutrient
39 value.

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1 Payment will be made under:

Pay Item	Pay Unit
Fertilizer Topdressing	Ton

2 **SECTION 1667**
3 **SPECIALIZED HAND MOWING**

4 **1667-1 DESCRIPTION**

5 This work consists of specialized hand mowing around or under fixed objects, including but
6 not limited to guardrails, signs, barriers and slopes in a method acceptable to the Engineer.

7 Specialized hand mowing shall be completed with mechanically powered trimmers, string
8 trimmers, hand operated rotary mowers or self-propelled mowers of sufficient size and quality
9 to perform the work timely and efficiently.

10 The quantity of mowing to be performed will be affected by the actual conditions that occur
11 during the construction of the project. The quantity of mowing may be increased, decreased
12 or eliminated entirely as directed. Such variations in quantity will not be considered as
13 alterations in the details of construction or a change in the character of the work.

14 **1667-2 MEASUREMENT AND PAYMENT**

15 *Specialized Hand Mowing* will be measured and paid as the actual number of manhours each
16 worker spends hand mowing, as directed. When directed to mow an area more than once,
17 separate measurement will be made each time the area is mowed.

18 Payment will be made under:

Pay Item	Pay Unit
Specialized Hand Mowing	Man Hour

19 **SECTION 1670**
20 **PLANTING**

21 **1670-1 DESCRIPTION**

22 Furnish, deliver and plant trees, shrubs, vines, ground covers, bedding plants and seedlings at
23 locations shown in the plans or as directed, in accordance with these Specifications.

24 The work of planting includes plant bed preparation, initial planting, plant establishment and
25 replacement planting.

26 Perform the operations carefully to promote the continued life and healthy growth of all plants
27 in their final location.

28 The actual conditions that occur during the construction of the project will determine the
29 quantity of plant bed fumigation or post-emergent and pre-emergent herbicidal treatment for
30 plant beds. The quantities of plant bed fumigation and post-emergent and pre-emergent
31 herbicidal treatment for plant beds may be increased, decreased or eliminated entirely as
32 directed. Such variations in quantity will not be considered as alterations in the details of
33 construction or a change in the character of the work.

34 **1670-2 MATERIALS**

35 Refer to Division 10.

Item	Section
Fertilizer	1060-2
Water	1060-9
Plant Materials - Nursery Grown	1060-10
Mulch for Planting	1060-11

Item	Section
Materials for Staking or Guying	1060-12
Herbicide	1060-13

- 1 Furnish nursery grown plant materials.
- 2 Use methyl bromide as fumigant consisting of a mixture of 80% methyl bromide and 20%
3 chloropicrin. A different ratio of fumigant containing methyl bromide and chloropicrin may
4 be used provided that the amount of active ingredient specified in Article 1670-7 is provided.
- 5 Use a 2 mil. polyethylene agricultural plastic sheeting free of holes, punctures and tears to
6 cover the fumigated plant beds. Use an appropriate width of plastic for the width of the plant
7 bed and obtain approval before fumigation.
- 8 The contract will state the kind of herbicides to be used.

9 **1670-3 WEATHER AND SEASONAL LIMITATIONS**

- 10 Perform planting operations only between the dates shown in the contract except where
11 otherwise permitted in writing.
- 12 Do not plant when the temperature is below 32°F, when the plant hole is frozen or when soil
13 to excavate and fill the plant hole is frozen or too wet.
- 14 Perform fumigation during or within 2 weeks before the time allowed for planting as shown in
15 the contract. Fumigate when the soil temperature is at least 55°F at a depth of 5" and
16 moderately moist (50-85% of field capacity).
- 17 Apply post-emergent herbicide when the weeds are near maturity but not when the weeds are
18 under stress from drought, disease, insect damage or any other cause.
- 19 Do not apply post-emergent herbicide when rain is likely within the next 6 hours or as
20 restricted on the product label.

21 **1670-4 CARE AND HANDLING PLANTS**

22 **(A) General**

- 23 Exercise utmost care in digging, loading, transporting, unloading, planting or otherwise
24 handling plants and use adequate precautions to prevent injury to or drying out of the
25 trunk, branches or roots; and to prevent freezing of the plant roots. Heel-in plants within
26 48 hours of delivery from the nursery, if they can not be planted within that time.
- 27 Properly maintain all heeled-in plants until planted. Do not have plants remain heeled-in
28 for more than 30 days. Open plants immediately when delivered in boxes or wrapped in
29 bundles or other forms of closed packages and inspect and dampen if necessary.

30 **(B) Balled and Burlapped Plants**

- 31 Protect the roots of balled and burlapped plants, if not immediately planted after delivery,
32 by adequately covering with a soil, mulch or sawdust that is kept moist constantly in
33 an acceptable manner appropriate to weather or seasonal conditions. Preserve the solidity
34 of the plant ball carefully.

35 **(C) Bare Rooted Plants**

- 36 Refrigerate or immediately heel-in all plants, if not promptly planted, in moist soil, mulch
37 or sawdust in an acceptable manner corresponding to generally accepted horticultural
38 practice.
- 39 Protect the plants from drying out by means of wet canvas, burlap or straw or by other
40 means acceptable while being transported or planted.

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1 (D) Geophytes

2 Geophytes; bulbs, corms and tuberous plants; that are being shipped shall be packaged in
3 containers that meet industry standards and have been pre-approved by the engineer. All
4 individual packages shall be clearly labeled with quantity and cultivar name.

5 While bulbs, corms and tuberous plants are being transported or are being distributed in
6 planting beds, or are awaiting planting after distribution, protect them from drying out by
7 means of wet canvas, burlap, or straw, or by other means acceptable to the Engineer and
8 appropriate to weather conditions and the length of time they will be out of the ground.
9 Care shall be taken to avoid unnecessary injury to the bulbs before planting.

10 Pre-plant cool treatment is required for plants planted in a USDA Climatic Zones 9
11 and 10. Storage of bulbs, corms and tuberous plants which do not require pre-plant cool
12 treatment shall be stored in open trays and placed in a 55°F - 65°F, dry place away from
13 frost and heat and never allowed to dry out to the point of shriveling. Packing in slightly
14 moist peat is preferred. The storage area shall be well-ventilated and ethylene-free. Do
15 not store bulbs with fruit such as apples or pears which produces ethylene gas which can
16 cause problems with flowering. Do not store bulbs in paper or plastic bags unless
17 otherwise specified or approved. If a refrigerator is used it shall be frequently ventilated.

18 **1670-5 PLANT LOCATION**

19 Locate and mark on the ground locations for plants and outlines for areas to be planted or
20 reforested and obtain approval before digging plant holes for beds.

21 Where so directed, furnish and install standard identification wires with plastic flags to
22 designate individual plants in major planting areas.

23 Flags will not necessarily be needed for all plants required by the contract, but use these flags
24 on portions of the project until plant locations in these portions are approved.

25 Unforeseen conditions may make it necessary to make minor adjustments in plant locations
26 due to utility lines, traffic signs, rock, drainage, etc., and such adjustments will be permitted
27 subject to approval.

28 **1670-6 PRUNING**

29 Prune shrubs and trees after planting as shown in the plans or as directed by the Engineer.
30 Pruning done at any time in no way alters the Department's right to reject plant material.
31 Prune in accordance with the International Society of Arboriculture pruning techniques, and
32 according to shape, size and condition of the individual plant.

33 **1670-7 PLANT BED TREATMENT**

34 **(A) General**

35 Treat plant beds by fumigation or by application of herbicides where called for by the
36 plans or directed.

37 **(B) License**

38 Make pesticide applications by or under the direct supervision of an applicator licensed
39 by the North Carolina Department of Agriculture and Consumer Services.

40 **(C) Fumigation**

41 Fumigate the plant beds with an approved fumigant in preparation for planting.

42 Before fumigation, level the plant bed to a proper planting grade. Till the bed to a depth
43 of 5" to 8". Prepare soil in good tilth with no dry clods over one inch in diameter present.
44 Cover with plastic tarp within 24 hours of soil preparation completion or other approved
45 process.

1 Apply the approved fumigant gas according to product labeling. If plastic is required
2 then Use envelope folds at the edges of the bed with the edge of the plastic buried 4"
3 to 6" deep.

4 Keep the plastic over the bed for 48 to 72 hours. Reform the bed to the required shape,
5 after removal of the plastic, with little or no soil inversion. Pursue continuous planting
6 within 24 hours of plastic cover removal.

7 **(D) Post-Emergent Herbicidal Treatment**

8 Post-emergent herbicidal treatment includes applications of a systemic post-emergent
9 total vegetation control herbicide.

10 The contract will state the rates of application of the post-emergent herbicides.

11 Apply all herbicides in accordance with the manufacturer's instructions on the product
12 label.

13 Apply post-emergent herbicide when the weeds are near maturity but not when the weeds
14 are under stress from drought, disease, insect damage or any other cause. If cloudy
15 weather or other poor growing conditions are present, extend this 7 day period until there
16 are visible signs of herbicidal activity. Reapply if necessary to achieve a thorough
17 control.

18 (1) Post-Emergent Application for Plant Bed Preparation

19 Apply a systemic post-emergent total vegetation control herbicide to the bed area
20 before any tilling or mowing is performed. Perform no tilling or mowing for at least
21 7 days after the application. Thoroughly till the bed after the waiting period, or when
22 injury to the vegetation appears. Prepare the soil in good tilth with no clods over one
23 inch present and before planting.

24 (2) Post-Emergent Application for Plant Bed Maintenance

25 Apply a systemic post-emergent herbicidal treatment in accordance with product
26 label in a manner to ensure no damage to planted material. Perform no mowing or
27 vegetation removal by other means for at least 7 days after the application.

28 **(E) Pre-Emergent Herbicidal Treatment**

29 Pre-emergent herbicidal treatment includes the application of a pre-emergent herbicide.

30 Apply a pre-emergent herbicide to the plant bed after the existing vegetation has been
31 completely controlled by a post-emergent herbicide application as specified in
32 Subarticle 1670-7(D) and after installation of planting and mulching as described in
33 Articles 1670-9 and 1670-10. Apply pre-emergent herbicide following planting and
34 mulching of plant bed before germination of weed seeds. An additional application of
35 post-emergent herbicidal treatment may be necessary to control emerged weeds, as
36 directed, if sufficient time has lapsed between tillage and installation of plant material
37 and mulch. No direct payment will be made for additional post-emergent herbicidal work
38 if such work is due to carelessness or neglect on the part of the Contractor.

39 Apply herbicide evenly over the soil surface with properly calibrated equipment at the
40 specified rate.

41 If at least 0.5" of rainfall does not occur within 15 days of application of pre-emergent
42 herbicidal treatment, apply at least 0.5" of water (2.8 gal/sy uniformly over the planting
43 area to activate the herbicide.

Section 1670

1 1670-8 EXCAVATION OF PLANT HOLES

2 Provide cylindrical shaped plant hole excavations for plants other than reforestation plants,
3 with the plant location stake marking the center of the circle and with the sides of the hole
4 being approximately vertical. When mechanical means are used which make digging of
5 cylindrical holes impractical, the complete hole shall have the minimum dimensions as shown
6 in the plans.

7 When plants are to be grouped together in a plant bed as contrasted to widely separated
8 individual plants, and when so indicated in the plans, loosen and pulverize clods to a depth of
9 not less than 5" for the entire area of the plant bed by means of a scarifier, disc, spade or other
10 appropriate means before plant holes are dug.

11 Plant reforestation plants in holes made by a planting spade, planting bar or other means
12 which meet the approval of the Engineer. Make the hole of sufficient size to accommodate
13 the entire extended root system of the plant without cramping.

14 When geophytes; bulbs, corms and tuberous plants; are to be grouped together in a plant bed
15 as contrasted to widely separated individual plants, and when so indicated in the plans, loosen
16 and pulverize clods to a depth of not less than 8", or as indicated in the plans, for the entire
17 area of the plant bed by means of a scarifier, disc, spade or other appropriate means before
18 plant holes are dug.

19 Place plants in holes made by a planting spade, planting bar or other means which meet the
20 approval of the Engineer. Make the hole of sufficient size to accommodate the entire plant
21 structure without cramping. Take care to plant all plants at a uniform depth as indicated in the
22 plans or directed by the Engineer.

23 When geophytes are to be planted separately as individual plants or in small separated groups,
24 loosen and pulverize clods with a spade, auger or other means which meet the approval of the
25 Engineer. Individual planting holes shall be to a depth of not less than 8", or sufficient size to
26 accommodate the entire plant structure without cramping or to a depth as indicated in the
27 plans or directed by the Engineer.

28 1670-9 PLANTING, BACKFILLING AND WATERING

29 (A) General

30 The plans will state the kind and rate of application of fertilizer. Apply fertilizer during
31 backfilling operations in a manner that will ensure proper placement of the fertilizer and
32 avoid injury to the roots.

33 Scarify the walls and floor of the plant hole after the plant hole is dug. Place the plant in
34 the prepared plant hole at the proper position as regards to depth, alignment, final grade
35 of the surrounding ground level and vertical placement of the trunk. Maintain this
36 position during all subsequent backfilling and watering operations. Set plants with the
37 root collar at the same depth as grown in the nursery or raise above grade as indicated in
38 the plans.

39 Moisten the soil with water after one-half to two-thirds of the backfilling and tamping has
40 been completed, if the soil in the plant holes is not sufficiently moist. Apply water to
41 moisten all soil but not a quantity that will saturate the soil to the extent of excluding all
42 air from around the roots. Place the remainder of the backfill after complete absorption
43 of water.

44 Construct water rings around all plants, except reforestation plants, in accordance with
45 details shown in the plans. A water ring consists of a ridge of firmed soil in a ring around
46 the plant and of a minimum inside diameter equal to the diameter of the plant hole. This
47 ridge is approximately 6" high and is compacted firmly enough to hold water.

1 (B) Balled and Burlapped Plants

2 Handle balled and burlapped plants by the ball and place in the plant hole so that the soil
3 of the ball will not be loosened from the roots. After the hole has been almost completely
4 backfilled and the soil thoroughly firmed under and around the ball, cut the burlap away
5 and remove from around the stem of the plant. Complete backfilling so as to avoid
6 loosening of the soil of the root ball.

7 (C) Container Grown Plants

8 Planting requirements for container grown plants are the same as applicable to balled and
9 burlapped plants. Remove container immediately before planting. During the removal of
10 the container, take sufficient precautions to ensure that the soil and roots inside the
11 container are undisturbed. Scarify roots when directed.

12 (D) Bare Rooted Plants

13 Before the plant is placed in the plant hole, cut off smoothly any bruised or broken parts
14 of roots. Place the plant in its proper position in the hole and backfill. Carefully place
15 the backfill material, worked around and under the roots and compacted in a manner that
16 avoids bruising or breaking the roots.

17 (E) Reforestation Plants

18 Reforestation includes tree reforestation and shrub reforestation. Type, mixture, size,
19 furnish description and spacing will be as shown on the reforestation detail sheet in the
20 plans.

21 Before beginning reforestation, each area to be reforested will be measured by the
22 Engineer to determine the exact number of acres for tree reforestation or square yards or
23 shrub reforestation therein and the quantity of each species of seedling to be planted
24 within the area.

25 Where structures or plantings do not adequately delineate the outline of the area to be
26 reforested, stake the outline of the area as directed by the Engineer. Furnish cypress,
27 cedar, oak, locust or other wood stakes approved by the Engineer. Provide stakes with
28 a minimum industry standard of 2" x 2" (nominal) size and approximately 30" in length
29 with a 15" white top. Drive stakes in the ground with approximately 18" remaining
30 above the ground line and place as necessary to define and delineate the reforestation
31 outline.

32 Ensure sample stock of reforestation seedlings are inspected by the Engineer, for general
33 health and moisture content, within 24 hours before planting.

34 After the plant hole has been prepared, place the plant upright in the hole at the correct
35 depth without crowding or bunching the roots. Firm the soil around the root system from
36 the bottom of the plant hole to natural ground elevation.

37 Upon completion of planting the required number of seedlings within all areas to be
38 reforested, the Contractor will be relieved of further responsibility in connection with
39 reforestation except for damage caused directly by the Contractor.

40 (F) Geophytes

41 When planting geophytes; bulbs, corms and tuberous plants; take care to place all plants
42 at a uniform depth as indicated in the plans or directed by the Engineer. All plants shall
43 be set upright as originally grown and at the proper spacing and depth from the natural
44 ground elevation. Soil that is backfilled into the hole to obtain the proper depth shall be
45 firmed before plant placement. Soil backfilled over the plant shall be firmed.

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1 Planting shall be accomplished when the soil temperature is 40°F to 45°F or as directed
2 by the Engineer. No phase of this work shall be performed when the temperature is
3 below 32°F, when the plant holes are frozen or when soil to excavate and fill the plant
4 hole is frozen or too wet.

5 Geophytes shall be watered as stated in the contract or as directed by the Engineer.
6 Watering will be required for geophytes if the soil in the plant hole is not sufficiently
7 moist. Apply water to moisten all soil, but not in a quantity that will create standing
8 water or saturate the soil to the extent of excluding all air from around the plant.

9 **1670-10 MULCH FOR PLANTING**

10 Place mulch within 7 days of initial planting as a top layer on the backfilled plant hole and
11 water ring. Place mulch approximately 4" deep as shown in the plans or as directed. Place
12 additional mulch as directed during establishment.

13 No mulching will be required for reforestation plants.

14 **1670-11 WATER FOR PLANTING**

15 Water at the time of planting as specified in Article 1670-9 and at the Contractor's election
16 and the Engineer's approval. Water with gravity flow or low pressure applicators which have
17 been approved, and which will not erode soil around the plant root system or damage to
18 plants. Saturate the soil around each plant thoroughly at each watering.

19 **1670-12 STAKING OR GUYING**

20 Stake or guy plants as shown in the plans or as directed to prevent damage.

21 Ensure that the plant is attached and held rigid to the support in a manner that will prevent
22 chafing or other injury to the bark, and that will permit normal development of the trunk or
23 branch.

24 **1670-13 INITIAL PLANTING**

25 Initial planting will be complete when the plants have been placed in the plant hole,
26 backfilled, fertilized, watered, mulched, staked and guyed, and the plants are in an acceptable
27 condition.

28 **1670-14 ESTABLISHMENT**

29 Begin establishment for all initial or replacement plants immediately after they are planted.
30 Maintain trees, shrubs, vines and groundcovers, and the area of planting until final acceptance
31 of the project. Mow and maintain the area around trees and shrubs for a distance of 6 ft
32 beyond the outside limits of water rings or 6 ft beyond the limits of the guy stakes, whichever
33 is greater; within shrub beds; and for a distance of 6 ft outside the perimeter of the shrub beds.
34 Establishment includes cutting of grass and control of weeds; watering; fertilization;
35 replacement of mulch; repair or replacement of guy stakes, guy wires and water rings; and
36 other work as directed to ensure the survival and growth of plant material and the satisfactory
37 appearance of the project. Remove dead plant material from the project during the
38 establishment period.

39 **1670-15 REPLACEMENT PLANTING**

40 Replacement planting of trees, shrubs and ground cover consists of replacing those plants
41 which are not in a living, healthy condition or do not conform to the Specifications contained
42 in *American Standard for Nursery Stock* or damaged or stolen. Replacement of reforestation
43 plants will not be required.

44 Perform replacement planting within the planting season specified in the contract.

1 **1670-16 FINAL INSPECTION**

2 All planting shall be completed and all plants shall be in a living and healthy condition at the
3 time of final inspection.

4 **1670-17 MEASUREMENT AND PAYMENT**

5 (*Plant Species and Size Indicated in Contract*) will be measured and paid in units of each,
6 other than reforestation plants, planted and accepted.

7 *Reforestation* will be measured and paid in acres of land measured along the surface of the
8 ground.

9 *Wetland Reforestation* will be measured and paid in acres of land, measured along the surface
10 of the ground.

11 *Plant Bed Fumigation* will be measured and paid in square yards of plant bed measured along
12 the surface of the ground.

13 *Post-emergent Herbicidal Treatment* will be measured and paid in square yards of plant bed
14 measured along the surface of the ground.

15 *Pre-emergent Herbicidal Treatment* will be measured and paid in square yards of plant bed
16 measured along the surface of the ground.

17 *Geophytes* (plant species and size indicated in contract) will be measured and paid in units of
18 each that have been planted and accepted.

19 *Mulch for Planting* will be measured and paid in cubic yards. Where mulch is furnished in
20 bales or bags, the number of cubic yards in each bale or bag will be determined and then
21 multiplied by the number of bales or bags of the same size which have been acceptably
22 furnished and placed. Where mulch is furnished in trucks, each truck will be measured by the
23 Engineer and shall bear a legible identification mark indicating its capacity. Load each truck
24 to at least its measured capacity at the time it arrives at the site of the work.

25 *Water for Planting* will be measured and paid in units of 1,000 gallon units. Measurement of
26 water will be made by means of an approved metering device at the source of supply, or by
27 determining the volumetric capacity of tank trucks used to deliver water to the project and
28 recording the number of loads delivered by each truck.

29 No payment will be made for plant bed preparation, tillage, staking or guying and
30 fertilization, for this work will be incidental to other work in the contract.

31 Payment will be made under:

Pay Item	Pay Unit
(Plant species and size indicated in contract)	Each
Reforestation	Acre
Wetland Reforestation	Acre
Plant Bed Fumigation	Square Yard
Post-Emergent Herbicidal Treatment for Plant Beds	Square Yard
Pre-Emergent Herbicidal Treatment for Plant Beds	Square Yard
Geophytes	Each
Mulch for Planting	Cubic Yard
Water for Planting	1,000 Gallons

DIVISION 17

SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEMS

SECTION 1700 GENERAL REQUIREMENTS

1700-1 DESCRIPTION

Furnish, install, modify and remove signals, flashing beacons, intelligent transportation systems, electrical systems and provisions for future systems.

1700-2 MATERIAL

Refer to Division 10.

Item	Section
Electrical Service Equipment	1098-1
Electrical Materials	1091

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

1700-3 CONSTRUCTION METHODS

(A) General

Before beginning signal work, verify all existing signal equipment is in satisfactory working order. Report all defective signal equipment to the Engineer so as not to be held responsible for defects.

Locate existing conduit, cable runs, inductive detection loops, lead-in cable, junction boxes and detection equipment before installing or using equipment that can damage or interfere with such facilities. The locations of existing inductive detection loops shown are approximate.

Locate all underground utilities before beginning drilling, digging or trenching operations.

Ensure that an IMSA certified, or equivalent, Level II traffic qualified signal technician is standing by to provide supervision and emergency maintenance services whenever work is being performed on traffic signal controller cabinets and traffic signal controller cabinet foundations. Stand by status is defined as being able to arrive, fully equipped, at the work site within 30 minutes ready to provide services.

Immediately cease work and notify the Engineer and affected owners if damage to existing utilities, cables or equipment occurs. Make all required repairs and replacements.

(B) Regulations and Codes

Comply with NCGS § 87, Article 4, Electrical Contractors. Comply with all regulations and codes imposed by the owner of affected utility poles.

Notify the Engineer, local traffic enforcement agency, local utility company and affected railroad companies 7 business days before operational shutdowns to coordinate connection or disconnection to an existing utility or system.

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1 Install standoffs, meter bases and service disconnects as required by the NESC, NEC,
2 local utility companies and local ordinances.

3 (C) Utility Services

4 Coordinate all work to ensure electrical power of proper voltage, phase, frequency and
5 ampacity is available to complete the work. Use electrical services cables with
6 THWN insulation.

7 When electrical, telephone and telecommunication service is not furnished by the
8 Department and is required, contact the utility company and make application to ensure
9 all work can be completed. Obtain authorization for service in the Department's name
10 and make application for service in the Department's name along with the associated
11 NCDOT Asset Inventory Number shown in the contract. Notify the Engineer
12 immediately if this number is not shown in the contract.

13 The Department will be responsible for direct payment of monthly utility company usage
14 charges. The Contractor will be responsible for all expenses associated with utility
15 installation costs, hookups, etc.

16 (D) Maintenance and Repair of Material

17 Furnish the Engineer with the name, office telephone number, cellular (mobile) telephone
18 number and pager number of the supervisory employee who will be responsible for
19 maintenance and repair of equipment during all hours.

20 Maintain and repair all signal and communications related equipment within the project
21 construction limits until completion of the observation period and receipt of written
22 notification of final acceptance of the project.

23 For all failures, malfunctions or damages to equipment, begin necessary repairs within
24 4 hours of notification. Complete repairs within 8 hours of notification. Comply with
25 Section 150 for maintenance of traffic flow. The inability to contact the supervisory
26 employee or prearranged alternate will not extend repair time requirements.

27 Remove and replace all signal and communications related equipment that fails. The
28 Department will furnish the Contractor replacement equipment for Department-furnished
29 equipment that fails.

30 Except for damages and malfunctions caused by the Contractor's work activities, the
31 Contractor will not be held responsible for pre-existing conditions reported to the
32 Engineer before starting traffic signal work at the specific intersection. The Contractor
33 will assume responsibility for all maintenance and emergency services necessary once
34 traffic signal work has begun at the specific intersection and for all damages and
35 malfunctions caused either directly or indirectly by the Contractor's work activities.

36 Perform maintenance (testing) on all Traffic Signal Conflict Monitors every 12 months
37 for the life of the project beginning with the initial test and every 12 months thereafter.
38 Provide the initial test date via the manufacturer's certification or via testing prior to
39 installation of the conflict monitor at an intersection. Use the ATSI Incorporated Model
40 PCMT-2600 Conflict Monitor Tester or an Engineer approved equivalent. Ensure that
41 the Conflict Monitor Tester is maintained and calibrated per the manufacturer's
42 recommendation. Provide to the Engineer a copy of the manufacturer's certification that
43 the Conflict Monitor Tester is in proper working order before testing the Traffic Signal
44 Conflict Monitors. Perform the test on the Traffic Signal Conflict Monitors per the
45 manufacturer's recommendation. For each Traffic Signal Conflict Monitor tested,
46 provide 2 dated copies of the test results: one copy for the Engineer and one copy for the
47 traffic signal cabinet.

1 In the event the Contractor fails to perform in accordance with the plans and *Standard*
2 *Specifications* within the time frame specified, the Department reserves the right to
3 perform maintenance and emergency service necessary to ensure continuous traffic signal
4 operation. Further, all expenses incurred by the Department in implementing this option
5 will be deducted from payment due the Contractor, plus \$2,500 liquidated damage per
6 occasion, per day, or any portion thereof, until corrected.

7 **(E) Inspections**

8 The Department may access the Contractor's equipment to perform railroad, signal and
9 preventative maintenance inspections or conflict monitor certification as necessary. The
10 Contractor shall be present for these inspections.

11 **(F) Removal of Existing Equipment and Material**

12 Remove all Department-owned signals and communications related equipment and
13 material that will not be used. Assume ownership of removed poles, messenger cable,
14 interconnect cable, communications cable and supporting hardware. Return all other
15 equipment and material between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to
16 the Traffic Services Office within the Division responsible for administration of the
17 project.

18 **(G) Railroad Preemption**

19 Where railroad preemption is required, coordinate all work with the railroad company.
20 Do not place signals into operation until signal equipment has been interconnected with
21 required railroad-highway crossing devices and railroad preemption is working properly.
22 Ensure preemption sequences begin immediately after activation of train detection.

23 Contact and coordinate with the railroad company to schedule interconnection of the
24 signal to the railroad controller cabinet. Install lead-in cable from the signal controller
25 cabinet to a railroad company furnished and installed lockable junction box.
26 Interconnection will be made by the railroad company.

27 Provide fail-safe operation such that removal of voltage from the railroad side of the
28 isolation relay will initiate the railroad preemption sequence.

29 **(H) Vehicle Preemption Systems**

30 Where required, implement and install vehicle preemption systems. Coordinate vehicle
31 preemption work with the proper operating authority. Contact the proper operating
32 authority and schedule installation of preemption equipment.

33 **(I) Timing of Signals**

34 Implement timing values for signal controllers. Modify proposed phasing and timing of
35 existing controllers.

36 Reinstall all existing time-based coordination. As directed, make modifications to
37 existing coordination to account for changes in signal phasing.

38 The Department reserves the right to make or have the Contractor make, field timing
39 changes necessary for pattern optimization and to eliminate identifiable, potential hazards
40 to the motoring public. The Engineer will notify the Contractor of timing changes made.

41 **(J) Wire and Cable**

42 For installation in a conduit system, lubricate cable and wires before installing in conduit.
43 Use lubricant that will not physically or chemically harm cable jacket, wire insulation or
44 conduit.

Section 1700

1 Terminate all electrical wire and cable at recessed-screw or barrier type terminal blocks.
2 Unless specifically allowed, connect no more than 2 conductors to the same terminal
3 screw.

4 Splice electrical wire and cable in junction boxes or condulets. Maintain color coding of
5 wires throughout each splice.

6 Protect ends of wire and cable from water and moisture.

7 **(K) Electrical Service and Grounding**

8 Where electrical services do not include an external electrical service disconnect, modify
9 service to include electrical service disconnect and a new grounding electrode system.

10 Provide a grounding electrode system at all new electrical services. In addition to
11 NEC requirements, test grounding electrode resistance for a maximum of 20 ohms.
12 Furnish and install additional ground rods to grounding electrode system as necessary to
13 meet test requirements.

14 Modify existing electrical services, as necessary, to meet the grounding requirements of
15 the NEC, these *Standard Specifications* and the project plans. Remove any ground rods
16 in the cabinet foundation and install a new grounding electrode system. Cut off
17 abandoned ground rods in the cabinet foundation flush with the foundation surface.
18 Where a grounding electrode system is connected to the electrical service in accordance
19 with the NEC, test grounding electrode resistance for a maximum of 20 ohms.
20 Grounding electrode resistance test shall be verified or witnessed by the Engineer or the
21 Engineer's designated representative. Furnish and install additional ground rods to
22 grounding electrode system as necessary to meet the *Standard Specifications* and test
23 requirements.

24 Follow test equipment's procedures for measuring grounding electrode resistance. When
25 using clamp-type ground resistance meters, readings of less than one ohm typically
26 indicate a ground loop. Rework bonding and grounding circuits as necessary to remove
27 ground loop circuits and retest. If a ground loop cannot be identified and removed to
28 allow the proper use of a clamp-type ground resistance meter, use the three-point test
29 method.

30 Submit a completed Inductive Loop & Grounding Test Form available on the
31 Department's website.

32 Provide a length of marker tape 6" to 12" below finished grade directly over grounding
33 electrodes and conductors.

34 **(L) Electrical Bonding**

35 Using an approved termination means, connect a #14 AWG minimum, 19-strand copper
36 conductor (Type THWN) with green insulation to serve as an equipment grounding
37 conductor to metal poles, vehicular and pedestrian signal pedestals and other metallic
38 components. Use messenger cables on wood poles and metal strain poles to provide
39 effective ground fault current path to cabinet ground.

40 **(M) Traffic Signal Activation**

41 Do not place signal in steady (stop-and-go) mode until inspected and authorized by the
42 Engineer.

(N) Temporary Traffic Signal Installations

When a traffic signal is installed for control of traffic during construction of the project and scheduled for removal during or upon completion of the project, install and remove the temporary traffic signal as required. Upon removal of the temporary traffic signal, restore surface to like-new condition. Rake smooth unpaved areas, repave paved areas and seed grassed areas that were damaged by Contractor activities.

Prepare intersection for sign control before removing the temporary traffic signal. Install required regulatory signs in accordance with Sections 900, 901 and 903. Cover signs with burlap bags until traffic signal is placed into flashing operation.

Place traffic signal into flashing operation and uncover signs simultaneously. Operate the flashing operation for a period of time as directed by the Engineer.

Signal cabinets, controllers, detector units, signal heads and accessories and microwave detectors are property of the Department. Return Department owned equipment between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project. Assume ownership of removed poles, messenger cable, interconnect cable, communications cable, supporting hardware and loop emulator detection equipment, unless otherwise specified.

1700-4 MEASUREMENT AND PAYMENT

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section.

Repair, removal and replacement of damaged or unacceptable equipment or work under this section will be at no additional cost to the Department. The Department will deduct the cost of Department-owned equipment damaged by the Contractor from money due to the Contractor.

If the Department performs maintenance and emergency service necessary to ensure continuous traffic signal operation, all expenses incurred by the Department in implementing this option will be deducted from payment due the Contractor, plus \$2,500 liquidated damage per occasion, per day or any portion thereof, until corrected.

SECTION 1705 SIGNAL HEADS

1705-1 DESCRIPTION

Furnish and install vehicle and pedestrian LED signal heads, visors, interconnecting brackets, wire entrance fittings, mounting assemblies, signal cable, lashing wire, pedestrian pushbuttons (and associated lead-in cable), pedestrian signal signs, grounding systems and all necessary hardware.

1705-2 MATERIAL

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

1705-3 CONSTRUCTION METHODS**(A) General**

Bag new pedestrian and vehicle signal heads with burlap bags or bags made of non-ripping material specifically designed for covering signal heads until signal heads are placed in operation. Do not use trash bags of any type.

Section 1705

- 1 When new signal heads are placed into operation, immediately bag and remove signals
- 2 heads that are not to be reused.
- 3 Adjust each signal head vertically and horizontally so that light output will be of
- 4 maximum effectiveness for traffic and pedestrians. Do not tilt signal heads forward.
- 5 Reposition signal heads as required for various construction phases.

(B) Vehicle Signal Heads

- 7 Install vehicle signal heads such that the top of the signal housing located over any
- 8 portion of a highway that can be used by motor vehicles is no more than 25.6 ft above the
- 9 pavement.
- 10 Install vehicle signal heads such that the maximum mounting height to the top of the
- 11 signal housing is as shown in Figure 1705-1 if the location is between 40 ft and 53 ft
- 12 from the stop line.

**Maximum Mounting Height of Signal Heads
Located Between 40 Feet and 53 Feet from Stop Line**

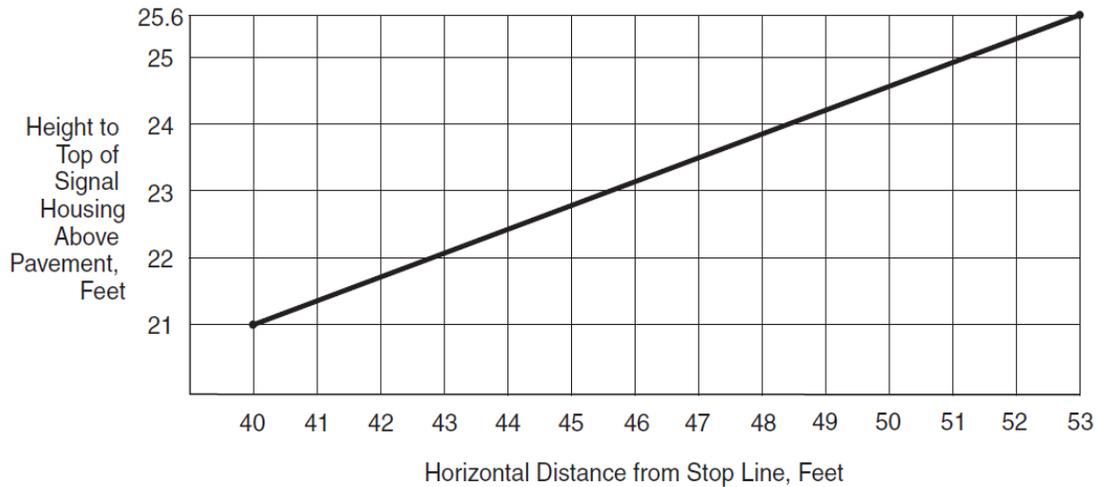


Figure 1705-1. Graph of maximum mounting height of signal heads.

- 15 Install vehicle signal heads such that the bottom of the signal housing and any related
- 16 attachments to the signal head located over any portion of a highway that can be used by
- 17 motor vehicles is at least 16.5 ft above the pavement directly below the signal head.
- 18 (1) Install vehicle signal heads such that the bottom of the signal housing (including
- 19 brackets) of a signal head that is vertically arranged and not located over a roadway
- 20 is as follows:
 - 21 (a) A minimum of 8 ft and a maximum of 19 ft above the sidewalk or, if there is no
 - 22 sidewalk, above the pavement grade at the center of the roadway.
 - 23 (b) A minimum of 8 ft and a maximum of 19 ft above the median island grade of
 - 24 a center median island if located on the near side of the intersection.
- 25 (2) Install vehicle signal heads such that the bottom of the signal housing (including
- 26 brackets) of a signal head that is horizontally arranged and not located over
- 27 a roadway is as follows:
 - 28 (a) A minimum of 8 ft and a maximum of 22 ft above the sidewalk or, if there is no
 - 29 sidewalk, above the pavement grade at the center of the roadway.

1 (b) A minimum of 8 ft and a maximum of 22 ft above the median island grade of
2 a center median island if located on the near side of the intersection.

3 Where vehicle signal heads are installed on messenger cable, install mounting hardware
4 consisting of messenger cable hanger, balance adjuster, bottom cap, wire entrance fitting
5 bracket and insulating bushings.

6 Where vehicle signal heads are installed on mast arms, install mounting hardware
7 consisting of rigid vehicle signal head mounting brackets.

8 Install signal cable in continuous lengths between signal controller cabinets and signal
9 heads. Route signal cable to minimize the length of cable installed and the number of
10 cables and conductors in each run. Pull 36" of additional signal cable into controller
11 cabinets.

12 Wrap signal cable to messenger cable with at least 4 turns of wrapping tape spaced at
13 intervals less than 15" or lash signal cable to messenger cable with one 360° spiral of
14 lashing wire per 12".

15 Make electrical connections inside each signal head, signal controller cabinet and
16 termination compartment in metal poles. Do not splice cable at any other point between
17 signal heads and controller cabinet.

18 Coil sufficient signal cable beside each vehicle signal head to accommodate head shifts
19 during various construction phases. For final signal head locations, coil 36" on each side
20 of signal head if signal cable comes from both directions. If signal cable terminates at the
21 signal head, coil 36" of signal cable on the same side as the cable run.

22 **(C) Pedestrian Signal Heads**

23 Install signs with mounting hardware immediately above pedestrian pushbuttons.

24 Mount the pushbutton or accessible pedestrian signal (APS) at a minimum height of 3.5 ft
25 but no higher than 4.0 ft above the adjacent pedestrian travelway.

26 Connect each pushbutton with a separate run of lead-in cable between the pushbutton and
27 the termination panel in the controller cabinet. Bond pushbutton housing and all metal
28 components to cabinet ground using lead-in cable ground.

29 Mount pedestrian signal heads so the bottom of the signal housing, including brackets, is
30 not less than 7 ft or more than 10 ft above sidewalk level. Position and adjust the heads
31 to provide maximum visibility at the beginning of the controlled crosswalk. Ensure
32 pedestrian signal heads and vehicular signal heads mounted on the same support are
33 physically separated from each other.

34 **(D) Optically-Programmed Vehicle Signal Sections**

35 Install vehicle signal heads with optically-programmed vehicle signal sections so that
36 movement of the vehicle signals head is restricted. Tightly tether vehicle signal heads at
37 the top and bottom when installed on messenger cable. Attach vehicle signal heads using
38 a mounting-bracket assembly that locks the vehicle signal head into position from the
39 back and restricts movement when installed on mast arms.

40 **(E) Louvers**

41 Attach the louvers to the visors using stainless steel hardware. Position the signal head to
42 give the viewing angle as shown in the plans.

43 **(F) Modify Existing Vehicle Signal Heads**

44 Modify existing vehicle signal heads as shown in the plans.

Section 1706

1 **1705-4 MEASUREMENT AND PAYMENT**

2 *Vehicle Signal Head* (____) and *Pedestrian Signal Head* (____) will be measured and paid as
3 the actual number of signal heads of each type of material (aluminum or polycarbonate), size
4 and number of sections furnished, installed and accepted.

5 *Vehicle Signal Head with Single Optically-Programmed Sections* will be measured and paid
6 as the actual number of signal heads containing a single optically-programmed section
7 furnished, installed and accepted.

8 *Vehicle Signal Head with Multiple Optically-Programmed Sections* will be measured and paid
9 as the actual number of signal heads containing multiple optically-programmed sections
10 furnished, installed and accepted.

11 *Louver* will be measured and paid as the actual number of signal sections for which louvers
12 have been furnished, installed and accepted.

13 *Modify Existing Vehicle Signal Head* will be measured and paid as the actual number of
14 existing vehicle heads modified and accepted.

15 *Signal Cable* will be measured and paid as actual linear feet of signal cable furnished,
16 installed and accepted. Measurement will be point to point with no allowance for sag.
17 Twenty-five feet will be allowed for vertical segments up or down poles.

18 *Lead-in Cable* will be measured and paid in accordance with Section 1726.

19 No measurement will be made of visors, wire entrance fittings, interconnecting brackets,
20 mounting assemblies, pedestrian pushbuttons, pedestrian signal signs and signal head shifts as
21 these are incidental to furnishing and installing signal heads. No measurement will be made
22 for drip loops, coiled sections or lashing wire as these are incidental to furnishing and
23 installing signal cable.

24 Payment will be made under:

Pay Item	Pay Unit
Vehicle Signal Head (____)	Each
Pedestrian Signal Head (____)	Each
Vehicle Signal Head With Single Optically-Programmed Sections	Each
Vehicle Signal Head With Multiple Optically-Programmed Sections	Each
Louver	Each
Modify Existing Vehicle Signal Head	Each
Signal Cable	Linear Foot

25 **SECTION 1706**
26 **BACKPLATES**

27 **1706-1 DESCRIPTION**

28 Furnish and install backplates for vehicle signal heads with all necessary hardware.

29 **1706-2 MATERIAL**

30 Refer to Division 10.

Item	Section
Backplates	1098-2

31 Furnish material, equipment and hardware under this section that is pre-approved on the
32 ITS and Signals QPL.

1 **1706-3 CONSTRUCTION METHODS**

2 Install backplates for vehicle signal heads so as not to interfere with the function of all door
3 hinges, signal section latches and mounting hardware. Do not bend or deform backplates
4 during installation. Gooseneck fittings may be installed in reverse to accommodate
5 backplates. Use stainless steel fasteners for attaching backplates to signal sections.

6 **1706-4 MEASUREMENT AND PAYMENT**

7 *Backplates* will be measured and paid in units of each, furnished, installed and accepted. No
8 measurement will be made for different sizes of backplates.

9 Payment will be made under:

Pay Item	Pay Unit
Backplate	Each

10 **SECTION 1710**
11 **MESSENGER CABLE**

12 **1710-1 DESCRIPTION**

13 Furnish and install messenger cable (spanwire) with cable clamps, machine bolts, eye bolts,
14 3-bolt clamps, eye nuts, split-bolt connectors and all necessary hardware.

15 **1710-2 MATERIAL**

16 Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Messenger Cable	1098-3
Pole Line Hardware	1098-6
Wire	1091-2

17 Furnish material, equipment and hardware under this section that is pre-approved on the
18 ITS and Signals QPL.

19 **1710-3 CONSTRUCTION METHODS**

20 Install guy assemblies before installing messenger cable.

21 Use 3/8" messenger cable for spans supporting vehicle signal heads and/or signs.

22 Use 1/4" messenger cable for spans supporting only cables unless otherwise specified.

23 For messenger cable crossing over railroad tracks, provide a minimum of 27 ft of vertical
24 clearance, unless otherwise specified.

25 For permanent installations, install messenger cable in continuous lengths with no splices
26 except where an insulator is required. With prior approval, existing messenger for temporary
27 installations may be extended instead of installing new messenger cable.

28 Tension messenger cable to eliminate appreciable sag and to match sag of surrounding
29 utilities. Otherwise, allow 3% to 4% sag of the span length between poles.

30 For mid-run spans using wood poles, attach messenger cable to the pole with a 3-bolt cable
31 clamp with J-hook consisting of 5/8" diameter machine bolts, J-hooks, washers and square
32 nuts to attach messenger cable to wood poles. Provide machine bolts that are 3" longer than
33 the pole diameter. For mid-run spans using metal or other Department-approved poles, attach
34 messenger cable to the pole with a 3-bolt clamp with J-hook secured to the metal pole via
35 a pole band clamp. Refer to *Metal Pole Standard Drawing Sheet M6* found on the
36 Department's website.

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1 When terminating spans at wood poles, connect messenger cable to a deadend strandwise
2 attached to the pole via a 5/8" diameter shoulder eye bolt or 5/8" diameter shoulder angle bolt
3 with 5/8" eye nut as shown in *Roadway Standard Drawings* No. 1720.01. When terminating
4 spans at metal or other Department-approved poles, connect messenger cable to a deadend
5 strandwise attached to the pole via a pole attachment clamp. Refer to *Metal Pole Standard*
6 *Drawing Sheet M6* as shown in the previous paragraph. Do not install more than one
7 messenger cable and strandwise assembly to a single metal or other Department-approved pole
8 attachment clamp. During installation, ensure that messenger cable is centered and directly
9 aligned at the pole clamp's attachment point such that the cable does not exert forces on the
10 sides of the clamp's attachment point.

11 Maintain electrical continuity at all splices.

12 **(A) Messenger Cable for Signal Heads or Lead-In Cable**

13 For messenger cable attached to joint use poles, install a new grounding system that
14 complies with Article 1720-3 for bonding messenger cable. If a pole ground exists on the
15 joint use pole, bond new pole grounding system to existing pole ground using #6 AWG
16 minimum solid bare copper grounding wire terminated with split bolt connectors or
17 parallel groove clamp at each end. If existing poles do not have a grounding system,
18 install new grounding system that complies with Article 1720-3.

19 **(B) Messenger Cable for Communications Cable**

20 For messenger cable attached to joint use poles, bond messenger cable to existing pole
21 ground at each end and at 1,300-ft intervals. Install bond using #6 AWG minimum solid
22 bare copper grounding wire terminated with split bolt connectors or parallel groove
23 clamp at each end. If existing poles do not have a grounding system, install new
24 grounding system that complies with Article 1720-3.

25 **(C) Messenger Cable for Multiple Cables**

26 On multiple messenger cable arrangements, connect all messenger cable ends with
27 #6 AWG minimum solid bare copper wire and bond with split bolt connectors or parallel
28 groove clamp and terminate to pole ground.

29 **1710-4 MEASUREMENT AND PAYMENT**

30 *Messenger Cable* (____) will be measured and paid as actual horizontal linear feet of
31 messenger cable furnished, installed and accepted. Measurement will be point to point with
32 no allowance for sag.

33 No measurement will be made of cable clamps, machine bolts, eye bolts, 3-bolt assemblies,
34 eye nuts, split bolt connectors and pole grounding systems as these will be incidental to
35 furnishing and installing messenger cable.

36 Payment will be made under:

Pay Item	Pay Unit
Messenger Cable (____)	Linear Foot

37 **SECTION 1715**
38 **UNDERGROUND CABLE INSTALLATION**

39 **1715-1 DESCRIPTION**

40 Furnish and install temporary lead-in cable or conduit for underground cable installation with
41 tracer wire, miscellaneous fittings, all necessary hardware, marker tape, backfill, graded stone,
42 paving materials and seeding and mulching.

1 **1715-2 MATERIAL**

2 Refer to Divisions 5 and 10.

Item	Section
Conduit	1091-3
Conduit Plug	1091-3(G)
Duct and Conduit Sealer	1091-4
Backfill	1018-2
Graded Stone	545-2 and 545-3

3 Furnish material, equipment and hardware under this section that is pre-approved on the
4 ITS and Signals QPL.

5 **1715-3 CONSTRUCTION METHODS**6 **(A) General**

7 Ensure conduit is free of moisture and debris before pulling cables.

8 Following installation of conduit where cable is not immediately installed or conduit is
9 for future use (spare), seal the ends of the conduit with a conduit plug. Secure a pull line
10 to the conduit plug in such a manner that it will not interfere with installation of the
11 conduit plug and provides a watertight seal.

12 Extend ends of conduit 2" to 4" above concrete surfaces and 4" above crushed stone
13 bases. For metallic conduit, install metallic bushings and bond conduits.

14 (1) Conduit

15 (a) Conduit Entering Junction Boxes

16 Terminate conduits installed for communications cables (fiber optics, twisted
17 pair, ethernet and coaxial) in oversized junction boxes. Do not install other
18 conduits in the oversized junction box unless otherwise specified.

19 Terminate conduits installed for signal wiring, including lead-in cable, in
20 standard size junction boxes unless otherwise specified.

21 For all conduits entering junction boxes, seal spare conduits with approved
22 conduit plugs. Seal conduits containing fiber-optic communications cable,
23 signal cable and lead-in cable with duct and conduit sealer.

24 (b) Conduit Entering Cabinet Foundations

25 For all conduits entering the cabinet through the cabinet foundation, seal spare
26 conduits with approved conduit plugs. Seal conduits containing fiber-optic
27 communications cable, signal cable and lead-in cable with duct and conduit
28 sealer.

29 (2) Tracer Wire

30 Install tracer wire in all conduits containing fiber-optic cable. Pull tracer wire
31 simultaneously in a continuous length with the fiber-optic cable. Where multiple
32 pulls of fiber-optic cable are required and conduit is placed in the same trench, only
33 one tracer wire is required. Where multiple pulls of fiber-optic cable are required
34 and conduits may separate into individual trenches, install a tracer wire in each
35 conduit run. Provide waterproof butt splices where tracer wire is spliced. Splicing
36 will be allowed only in cabinets and junction boxes. Label all tracer wires entering
37 the equipment cabinet.

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1 (3) Plan of Record Drawings

2 Upon completion of the conduit system for communications, furnish the Engineer
3 with a plan of record drawing detailing the locations of the conduit system.

4 (B) Trenching

5 In certain cases the Contractor may use an alternate material and method of installation
6 between trenching and plowing based on existing field conduits and preferences. Obtain
7 approval before proceeding.

8 (1) General

9 Install PVC, HDPE or rigid metallic conduit for all underground runs. Install rigid
10 metallic conduit for all underground runs located inside railroad right-of-way. Clean
11 existing underground conduit to be incorporated into a new system. Bond all
12 metallic conduit.

13 If more than one conduit is required between the same points, install conduit in one
14 common trench. Install non-detectable marker tape.

15 Install longitudinal runs of conduit a minimum of one foot from back of curb or 6 ft
16 from edge of pavement in the absence of curb. If ditches are present, install conduit
17 a minimum of 4 ft from the bottom of the ditch line.

18 Maintain a minimum trench depth of 30" (or 12" in areas blocked by rock or
19 impenetrable obstructions) below finished grade or 6" below roadway subbase,
20 whichever is deeper. Upon completion, restore surface to like-original condition
21 within 7 calendar days of occurrence of damage. Remove all rock and debris from
22 backfill material. Remove excess material from site and compact area according to
23 Article 300-7. Backfill with excavated material and compact to 95% of original
24 density.

25 Backfill trench at locations along the trench path where non-movable objects, such as
26 rocks and boulders, cannot be avoided. The purpose of the backfill is to provide
27 a gradual change in elevation of the trench, so that excessive bending and stress will
28 not be transferred to conduits once underground conduit system is installed.

29 After installation of conduits and upon completion of tamping and backfilling,
30 perform a mandrel test on each conduit to ensure no conduit has been damaged.
31 Furnish a non-metallic mandrel having a diameter of approximately 50% of the
32 inside diameter of the conduit in which it is to be pulled through. If damage has
33 occurred, replace the entire length of conduit. Ensure pull line is re-installed.

34 (2) Unpaved Trenching

35 Install conduit in all unpaved areas for all cable including permanent traffic signal
36 installations.

37 As shown in plans or as directed by the Engineer, direct bury lead-in cable for
38 temporary traffic signal installations.

39 Rake smooth the top 1 1/2" and seed with same type of grass as surrounding area.
40 Finish unpaved areas flush with surrounding natural ground.

41 (3) Paved Trenching

42 On concrete surfaces, replace the entire joint of concrete unless otherwise specified.
43 On all other surfaces, neatly cut and replace the width of trench with like material.

1 Finish paved areas with materials matching damaged areas. For conduit installed
 2 under roadways, cut neatly and replace the width of paved area damaged by
 3 trenching. For conduit installed under sidewalks and walkways, remove entire
 4 section of slab from joint to joint and replace. Place graded stone material to
 5 temporarily maintain traffic where repairs cannot be performed immediately.
 6 Comply with Article 545-4.

7 **(C) Plowing (HDPE Conduit Only)**

8 Direct plow HDPE ducts simultaneously using chute plow method. Direct plow ducts at
 9 a minimum depth so the top of the highest duct is 30" deep unless otherwise approved.

10 Provide sufficient personnel to feed chute, operate prime mover and equipment carrying
 11 reels (if separate equipment is used), observe chute feeding, observe plowing and observe
 12 reel payout. Use chute with adequate dimensions to allow for passage of duct without
 13 damage. During plow operation, continuously check chute opening and path to be sure
 14 there are no obstructions and monitor payout reels to be sure reels are turning at a steady
 15 rate.

16 With prior approval, install a junction box at locations where splicing or coupling of the
 17 underground polyethylene conduits is necessary. Otherwise, splicing or joining of
 18 underground polyethylene conduit is prohibited.

19 **(D) Directional Drilling**

20 (1) Pre-Approvals and Minimum Depth Requirements

21 Obtain approval before beginning drilling operations.

22 At all points where HDPE conduit will traverse under roadways, driveways,
 23 sidewalks or Controlled Access Areas including entrance/exit ramps, maintain
 24 a minimum depth of 4 ft or 8 times the back reamer's diameter, whichever is deeper.
 25 For an installation that runs parallel to a controlled access area or entrance/exit ramps
 26 maintain a minimum depth of 30" below finished grade. Maintain a minimum
 27 clearance of 30" below finished grade when crossing ditch lines. For the following
 28 structures, the minimum clearance requirements are:

TABLE 1715-1 MINIMUM CLEARANCE REQUIREMENTS FOR STRUCTURES	
Man-made Structure	Minimum Clearance Requirement
Bridge Foundation	5 ft horizontal and 4 ft vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10 ft horizontal should be no deeper than 8 ft)
Drainage Pipes 60" or Less	1 ft above or below [while maintaining a minimum depth of 30" below grade]
Drainage Pipes Greater than 60"	1 ft above or 4 ft below [while maintaining a minimum depth of 30" below grade]
Box Culverts	1 ft above or 4 ft below [while maintaining a minimum depth of 30" below grade]
Slope Protection	2 ft below
Slope Protection Foundation Footing	5 ft below

29 Guarantee the drill rig operator and digital walkover locating system operator are
 30 factory-trained to operate the make and model of equipment provided and have at
 31 least one year experience operating the make and model of drill rig. Submit
 32 documentation of the operators' training and experience for review at least 2 weeks
 33 before start of directional drilling operations.

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1 Provide a means of collecting and containing drilling fluid/slurry that returns to the
2 surface such as a slurry pit. Provide measures to prevent drilling fluids from entering
3 drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from
4 accumulating on or flowing onto pedestrian walkways, driveways and streets.
5 Immediately remove all drilling fluids/slurry that are accidentally spilled.

6 (2) Directional Drill Operations

7 Provide grounding for the drill rig in accordance with the manufacturer's
8 recommendations.

9 Place excavated material near the top of the working pit and dispose of properly.
10 Backfill pits and trenches to facilitate drilling operations immediately after drilling is
11 completed.

12 Use drill head suitable for type of material being drilled and sized no more than
13 2" larger than the outer diameter of the conduit. Direct drill to obtain proper depth
14 and desired destination. Pressure grout with an approved bentonite/polymer slurry
15 mixture to fill all voids. Do not jet alone or wet bore with water.

16 During drilling operation, locate drill head every 10 ft along drill path and before
17 traversing underground utilities or structures. Use digital walkover locating system
18 to track drill head during directional drilling operation. Ensure locating system is
19 capable of determining pitch, roll, heading, depth and horizontal position of the drill
20 head at any point.

21 Once drill head has reached final location, remove head and install back reamer of
22 appropriate size (no more than 2" larger than outer diameter of conduits) to
23 simultaneously facilitate back reaming of drill hole and installation of conduit. Back
24 reamer is sized larger than actual conduits to ensure conduits are not adversely
25 subjected to deviations caused by the original drill operation and are as straight as
26 practical in their final position.

27 The intent of these Specifications is to limit the diameter of the actual drill shaft/hole
28 so that it is no more than 2" larger than the conduit outer diameter. The 2" larger
29 diameter may be accomplished during the original bore or during the back
30 reaming/conduit installation process.

31 Once installation of conduit has started, continue installation without interruption so
32 as to prevent conduit from becoming firmly set. Apply bentonite/polymer slurry
33 mixture during conduit installation.

34 Upon completion of conduit installation, perform a mandrel test on conduit system to
35 ensure conduit has not been damaged. Furnish non-metallic mandrel with a diameter
36 of approximately 50% of the inside diameter of the conduit in which it is to be pulled
37 through. If damage has occurred, replace the entire length of conduit and ensure that
38 pull line is re-installed.

39 (3) Drilling Fluids

40 Use lubrication for subsequent removal of material and immediate installation of the
41 conduit. The use of water and other fluids in connection with directional drilling
42 operations will be permitted only to the extent necessary to lubricate cuttings. Do
43 not jet alone or wet bore with water. Use drilling fluid/slurry consisting of at
44 least 10% high-grade bentonite/polymer slurry to consolidate excavated material and
45 seal drill hole walls.

46 Transport waste drilling fluid/slurry from site and dispose of in a method that
47 complies with Federal, State and local laws and regulations.

1 (4) Conduit Splicing

2 With prior approval, install a junction box at locations where splicing or coupling of
3 conduit is necessary. Otherwise, splicing or joining of HDPE conduit is prohibited.

4 (E) Bore and Jack

5 For bore and jack areas, comply with Articles 1540-4 except as follows:

6 For bore and jack areas, install metallic conduit at a minimum depth of 30" below
7 finished grade or 6" below roadway subbase, whichever is greater. Provide
8 a 3 ft clearance to conduit from back of curb or from edge of pavement. Terminate ends
9 of conduit into junction boxes.

10 Comply with the *NCDOT Policies and Procedures for Accommodating Utilities on Highway*
11 *Rights-of-Way* in effect on the date of advertisement.

12 **1715-4 MEASUREMENT AND PAYMENT**

13 *Tracer Wire* will be measured along the horizontal linear feet of tracer wire furnished,
14 installed and accepted. Measurement will be along the approximate centerline of the conduit
15 system. Payment will be made in linear feet. No payment will be made for excess tracer wire
16 in junction boxes and/or cabinets.

17 *Unpaved Trenching (qty)(size) & (qty)(size)* will be measured horizontal linear feet of
18 trenching for underground conduit installation of each type furnished, installed and accepted.
19 Measurement will be along the approximate centerline of the conduit system. Payment will
20 be in linear feet.

21 *Unpaved Trenching for Temporary Lead-in* will be measured in horizontal linear feet of
22 trenching for placement of temporary lead-in cable. Measurement will be along the
23 approximate centerline of the trench. Payment will be in linear feet.

24 *Paved Trenching (qty)(size) & (qty)(size)* will be measured horizontal linear feet of trenching
25 for underground conduit installation of each type furnished, installed and accepted.
26 Measurement will be along the approximate centerline of the conduit system. Payment will
27 be in linear feet.

28 *Plowing (qty)(size) & (qty)(size)* will be measured horizontal linear feet of plowing for
29 underground conduit installation furnished, installed and accepted. Measurement will be
30 along the approximate centerline of the conduit system. Payment will be in linear feet.

31 *Directional Drill (qty)(size) & (qty)(size)* will be measured horizontal linear feet of directional
32 drill for underground conduit installation furnished, installed and accepted. Measurement will
33 be along the approximate centerline of the conduit system. Payment will be in linear feet.

34 *Bore and Jack (qty)(size) & (qty)(size)* will be measured in horizontal linear feet of bore and
35 jack for underground conduit installation furnished, installed and accepted. Measurement will
36 be along the approximate centerline of the bore from junction box to junction box. Payment
37 will be in linear feet.

38 No measurement will be made of vertical segments, non-metallic conduit, metallic conduit,
39 conduit sealing material, backfill, graded stone, paving materials, miscellaneous fittings,
40 non-detectable marker tape, pull lines and seeding and mulching as these will be incidental to
41 conduit installation.

42 Conduit will be paid per linear foot based on quantity and size of conduits. As examples,
43 an installation of a single 1.25" HDPE conduit would be paid as:

44 Directional Drill (1)(1.25") Linear Foot, and

45 An installation of two 1.25" and four 2" HDPE conduits would be paid as:

46 Directional Drill (2)(1.25")&(4)(2") Linear Foot.

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1 Payment will be made under:

Pay Item	Pay Unit
Tracer Wire	Linear Foot
Unpaved Trenching (qty)(size) & (qty)(size)	Linear Foot
Unpaved Trenching for Temporary Lead-in	Linear Foot
Paved Trenching (qty)(size) & (qty)(size)	Linear Foot
Plowing (qty)(size) & (qty)(size)	Linear Foot
Directional Drill (qty)(size) & (qty)(size)	Linear Foot
Bore and Jack (qty)(size) & (qty)(size)	Linear Foot

2 **SECTION 1716**
3 **JUNCTION BOXES**

4 **1716-1 DESCRIPTION**

5 Furnish and install junction boxes (pull boxes) with covers, graded stone, grounding systems
6 and all necessary hardware.

7 **1716-2 MATERIAL**

8 Refer to Division 10.

Item	Section
Junction Box	1098-5
Graded Stone	545

9 Furnish material, equipment and hardware under this section that is pre-approved on the
10 ITS and Signals QPL.

11 **1716-3 CONSTRUCTION METHODS**

12 Install standard size junction boxes as shown in the plans and where underground splicing of
13 electrical cables is necessary. Install standard size junction boxes within 3 ft of pole or pole
14 foundation where transitioning from below ground to a riser assembly. Install standard size
15 junction boxes within 5 ft of each end of each lateral run of conduit for electrical cables.
16 When lateral runs for electrical cables are greater than 150 ft, install additional junction boxes
17 to ensure distances between junction boxes does not exceed 150 ft.

18 Install oversized junction boxes for fiber-optic cables at locations shown in the plans.

19 Provide real world coordinates for all junction boxes and equipment cabinets installed or used
20 under this project. Provide the coordinates in feet units using the North Carolina State Plane
21 coordinate system (1983 North American Datum also known as NAD '83). Furnish
22 coordinates that do not deviate more than 1.7 ft in the horizontal plane and 3.3 ft in the
23 vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data
24 within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect
25 the data for approval by the Engineer.

26 Provide both a digital copy and hard copy of all information regarding the location (including,
27 but not limited to, manufacturer, model number, and NCDOT inventory number) in the
28 Microsoft® spreadsheet provided by the Department, shown by example in Figure 1716-1.

NCDOT Inv #	Name	Location	Latitude	Longitude	Manufacturer	Model #
05-0134	Equipment Cabinet	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5500	35.6873	McCain	Type-332
05-0134	Junction Box # 1 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5516	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 2 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5506	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 3 (Near Cabinet)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5501	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 4 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5486	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 5 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5493	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 6 (Phase 4 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5503	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)

1 **Figure 1716-1. Spreadsheet.** Submit coordinate information in a spreadsheet provided by
2 the Department and in accordance with this article.

3 **1716-4 MEASUREMENT AND PAYMENT**

4 *Junction Box* (____) will be measured and paid in actual number of junction boxes of each
5 size and type furnished, installed and accepted.

6 No measurement will be made of covers, graded stone and grounding systems as these will be
7 incidental to furnishing and installing junction boxes.

8 Payment will be made under:

Pay Item	Pay Unit
Junction Box (____)	Each

9 **SECTION 1720** 10 **WOOD POLES**

11 **1720-1 DESCRIPTION**

12 Furnish and install poles, grounding systems and all necessary hardware.

13 **1720-2 MATERIAL**

14 Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Inspection Requirements	1082
Wire	1091-2
Wood Poles	1082

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1 Furnish material, equipment and hardware under this section that is pre-approved on the
2 ITS and Signals QPL for wood poles available on the Department’s website.

3 **1720-3 CONSTRUCTION METHODS**

4 Mark final pole locations and receive approval before installing poles. Unless otherwise
5 specified, locate poles a minimum of 6 ft behind face of curb or 10 ft from edge of travelway.
6 Ensure poles are of sufficient length to maintain the minimum required clearances above the
7 roadway, obstructions and affected railroad tracks.

8 Drill or auger a hole for placement of pole and to allow for compacting. Set pole at
9 manufacturer’s recommended depth, but at a minimum depth of 5 ft. Ensure the pole is within
10 2 degrees of vertical when fully loaded.

11 Backfill hole with pole installed and tamp backfill in 6 inch lifts with a mechanical tamp until
12 compacted density is at least 95% of original density.

13 On new Department-owned poles, install a grounding system consisting of #6 AWG solid
14 bare copper wire that is exothermically welded to a single ground rod installed at base of pole
15 or to the electrical service grounding electrode system located within 10 ft of the pole. Install
16 ground wire so as to minimize damage from vandalism and environmental exposures. Install
17 ground wire up pole to a point adjacent to the uppermost span. Use hot-dipped galvanized
18 wire staples to secure ground wire to pole.

19 **1720-4 MEASUREMENT AND PAYMENT**

20 *Wood Pole* will be measured and paid as the actual number of wood poles furnished, installed
21 and accepted.

22 No measurement will be made for installing grounding systems as these will be incidental to
23 furnishing and installing wood poles.

24 Payment will be made under:

Pay Item	Pay Unit
Wood Pole	Each

25 **SECTION 1721**
26 **GUY ASSEMBLIES**

27 **1721-1 DESCRIPTION**

28 Furnish and install guy assemblies with all necessary hardware.

29 **1721-2 MATERIAL**

30 Refer to Division 10.

Item	Section
Guy Assembly	1098-7
Pole Line Hardware	1098-6

31 Furnish material, equipment and hardware under this section that is pre-approved on the
32 ITS and Signals QPL.

33 **1721-3 CONSTRUCTION METHODS**

34 **(A) Guy Assemblies for Signal Heads or Lead-in Cable**

35 Install guy assemblies with guy cable, guy guards, anchors, 3-bolt clamps and associated
36 fittings. Use 2-bolt attachment method where there is adequate room on the pole to
37 comply with the NESC. Attach guy assembly and guy cable to 2 separate bolts with one
38 bolt for span and one bolt for guy cable.

1 Where adequate spacing is not available and a violation of the NESC would occur with
 2 the 2-bolt attachment method, use approved one-bolt attachment method for attaching
 3 messenger cable and guy assembly.

4 Bond guy assembly to new pole grounding system as described in Article 1720-3.

5 Do not attach to existing guy assemblies unless specifically approved by owner.

6 **(B) Guy Assemblies for Communications Cable**

7 When installing messenger cable for supporting only communications cable, use
 8 approved one-bolt attachment method for attaching messenger cable and guy assembly.

9 Bond guy assembly to existing pole ground using parallel groove clamp or equivalent.
 10 If existing poles do not have a grounding system, install new grounding system for
 11 bonding guy assembly that complies with Article 1720-3.

12 Do not attach to existing guy assemblies unless specifically approved by owner.

13 **1721-4 MEASUREMENT AND PAYMENT**

14 *Guy Assembly* will be measured and paid as the actual number of guy assemblies furnished,
 15 installed and accepted.

16 No measurement will be made of guy cable, guy guards, anchors, clamps, grounding systems
 17 or fittings as these will be incidental to furnishing and installing guy assemblies.

18 Payment will be made under:

Pay Item	Pay Unit
Guy Assembly	Each

19 **SECTION 1722**
 20 **RISER ASSEMBLIES**

21 **1722-1 DESCRIPTION**

22 Furnish and install riser assemblies with clamp-on, aluminum weatherheads or heat shrink
 23 tubing, galvanized pole attachment fittings and all necessary hardware.

24 **1722-2 MATERIAL**

25 Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Pole Line Hardware	1098-6
Rigid Metallic Conduit	1091-3
Riser Sealing Devices	1098-4
Wire	1091-2

26 Furnish material, equipment and hardware under this section that is pre-approved on the
 27 ITS and Signals QPL.

28 **1722-3 CONSTRUCTION METHODS**

29 Install risers with required weatherheads or heat shrink tubing on poles using pole attachment
 30 fittings. Maintain a 10" minimum and 18" maximum offset from signal messenger to the top
 31 of riser for all risers. On utility-owned poles, maintain a 40" offset from electrical utility's
 32 power conductors to top of riser and riser attachment fittings.

33 Use approved heat shrink tubing retrofit kits when installing new fiber-optic or coaxial cable
 34 into exiting risers that contain existing fiber-optic or coaxial cables.

35 Install heat shrink tubing retrofit kits in existing risers as specified.

Section 1722

- 1 Use separate 1/2" riser with weatherhead for pedestrian pushbutton.
- 2 Use separate 1" riser with weatherhead for electrical service.
- 3 Use separate 2" riser with weatherhead for signal cables (bundled). Use separate 2" riser with
- 4 weatherhead for the combination of all lead-in and twisted-pair communications cable. Install
- 5 conduit on all risers for lead-in cable.
- 6 Install condulets on risers for lead-in cable, railroad preempt interconnection cables and signal
- 7 pedestals.
- 8 Use separate 2" riser with heat shrink tubing for fiber-optic communications cables and
- 9 coaxial cable. Install risers with heat shrink tubing so that cable can be installed without
- 10 violating its minimum bending radius. Install cable so it does not share a riser with any other
- 11 cable.
- 12 Install heat shrink tubing in accordance with manufacturer's recommendations. Provide
- 13 tubing a minimum of 5" in length with a minimum of 2.5" extended over cables and
- 14 2.5" extended over risers after heat has been applied. Use nylon filler rods with
- 15 UV protection or equivalent and sealing spacer clips to separate cables where multiple cables
- 16 enter a riser. Ensure sealing spacer clips have a heat activated sealing compound with the
- 17 sealing compound fully encapsulating the space between cables. Ensure heat shrink tubing
- 18 provides a watertight fit around individual cables and outer walls of risers. Do not use cut
- 19 sections of cable or any other devices instead of filler rods. Use aluminum tape around cables
- 20 to prevent damage from sealing chemicals. Use a heat source that will provide even heat
- 21 distribution around tubing. Ensure no damage occurs to any cables.
- 22 Bond new risers, a minimum of 10 ft above grade, to the pole ground using a #6 AWG
- 23 minimum solid bare copper wire and an approved pipe clamp, a split bolt connector or
- 24 parallel groove clamp. On pole mounted cabinets where the riser are connected to the cabinet,
- 25 bond risers in the cabinet using ground bushings with a #6 AWG minimum solid bare copper
- 26 wire to the cabinet ground bus.
- 27 If a pole ground exists on the joint use pole, bond new riser to existing pole ground using
- 28 #6 AWG minimum solid bare copper wire terminated with split bolt connectors or parallel
- 29 groove clamp.
- 30 If existing poles do not have a grounding system, install new grounding system that complies
- 31 with Article 1720-3 for bonding messenger cable.
- 32 Transition from rigid galvanized steel risers to underground PVC conduits using an approved
- 33 rigid galvanized steel sweeping elbow with PVC female adaptor.

1722-4 MEASUREMENT AND PAYMENT

- 35 ___" Riser with ___ will be measured and paid as the actual number of risers of each type and
- 36 size furnished, installed and accepted. No measurement will be made of weatherheads, heat
- 37 shrink tubing or pole attachment fittings as these will be incidental to furnishing and installing
- 38 risers.
- 39 *Heat Shrink Tubing Retrofit Kit* will be measured and paid as the actual number of heat shrink
- 40 tubing retrofit kits furnished, installed and accepted.
- 41 Payment will be made under:

Pay Item	Pay Unit
___" Riser with ___	Each
Heat Shrink Tubing Retrofit Kit	Each

SECTION 1725
INDUCTIVE DETECTION LOOPS

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1725-1 DESCRIPTION

Furnish and install inductive detection loops with loop slot sealant, loop wire, conduit with fittings and all necessary hardware.

1725-2 MATERIAL

Refer to Division 10.

Item

Inductive Detection Loops

Section

1098-8

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

Provide the Engineer a Type 3 material certification and MSDS for the sealant in accordance with Article 106-3.

1725-3 CONSTRUCTION METHODS

All work performed in this section shall be done in the presence of the Engineer.

Notify Engineer one week before installing inductive detection loops.

Coordinate sawcutting and loop placement with pavement markings. For new construction or for resurfacing, install inductive detection loops before placing final layer of surface course. On unmarked pavement, pre-mark locations of stop lines and lane lines before locating inductive detection loops.

Before sawcutting, pre-mark inductive detection loop locations and receive approval. Sawcut pavement at approved pre-marked locations. Do not allow vehicles to travel over unsealed loop slots.

Install conduit with bushings from edge of pavement to junction box. Do not sawcut through curb.

Remove all loose material and wash saw slots with a high-pressure method using an air and water mixture. Dry saw slots with compressed air. Clear saw slots of jagged edges and protrusions. Seat loop conductor at bottom of saw slot without damaging loop wire.

Before sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megohms. For each location with inductive loops, submit a completed Inductive Detection Loop & Grounding Test Results form and place copy in controller cabinet. Ensure all loops are included on form. The form is located on the Department's website.

Embed loop conductors in saw slot with loop sealant. Seal saw slot and dispose of excess sealant in an environmentally safe manner.

Between where loop conductor pairs leave saw cut in pavement and junction boxes, twist loop conductor pairs a minimum of 5 turns per foot. Permanently label each twisted pair in the junction box with nylon cable tie using indelible ink. Indicate loop number and loop polarity on the tie.

1725-4 MEASUREMENT AND PAYMENT

Inductive Loop Sawcut will be measured and paid as the actual linear feet of inductive loop sawcut furnished, installed and accepted.

No measurement will be made of loop slot sealant, loop wire, conduit and conduit fittings as these will be incidental to furnishing and installing inductive detection loops.

Section 1726

1 Payment will be made under:

Pay Item

Inductive Loop Sawcut

Pay Unit

Linear Foot

2

**SECTION 1726
LEAD-IN CABLE**

3

4 **1726-1 DESCRIPTION**

5 Furnish and install lead-in cable with all necessary hardware to be used in conjunction with,
6 but not limited to, inductive detection loops, pedestrian pushbutton assemblies,
7 APS assemblies or railroad circuitry.

8 **1726-2 MATERIAL**

9 Refer to Division 10.

Item

Lashing Wire and Hardware
Lead-In Cable
Wrapping Tape

Section

1098-6
1098-9
1098-6

10 Furnish material, equipment and hardware under this section that is pre-approved on the
11 ITS and Signals QPL.

12 **1726-3 CONSTRUCTION METHODS**

13 For underground runs, install lead-in cable in 2" non-metallic conduit. For aerial installation,
14 wrap lead-in cable to messenger cable with at least 4 turns of wrapping tape spaced at
15 intervals less than 15" or lash lead-in cable to messenger cable with one 360° spiral of lashing
16 wire per 12".

17 Where railroad preemption is required, install lead in cable from signal controller cabinet to
18 railroad company furnished and installed lockable junction box.

19 Splicing of lead-in cable will be allowed only for runs in excess of 750 ft. Splice lead-in
20 cable in junction boxes or condulets on poles.

21 Test each complete loop system from the controller cabinet by using a megger to verify that
22 impedance from the loop system to the ground is at least 50 megaohms. After successful
23 completion of megger test, test loop system resistance using an electronic ohmmeter to verify
24 loop system resistance is less than 0.00885 ohms per foot.

25 **1726-4 MEASUREMENT AND PAYMENT**

26 *Lead-in Cable* (____) will be measured and paid as the actual linear feet of lead-in cable
27 furnished, installed and accepted. Measurement will be made by calculating the difference in
28 length markings located on outer jacket from start of run to end of run for each run.
29 Terminate all cables before determining length of cable run.

30 If markings are not visible, measurement will be point to point with no allowance for sag.
31 Twenty-five feet will be allowed for vertical segments up or down poles.

32 Payment will be made under:

Pay Item

Lead-in Cable (____)

Pay Unit

Linear Foot

**SECTION 1730
FIBER-OPTIC CABLE**

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1730-1 DESCRIPTION

Furnish and install single mode fiber-optic (SMFO) communications cable and drop cable assemblies, fiber-optic cable storage racks (snow shoes), communications cable identification markers, lashing wire and all necessary hardware.

1730-2 MATERIAL

Refer to Division 10.

Item	Section
Cable Identification Markers	1098-10
Fiber-Optic Cable	1098-10
Lashing Wire and Hardware	1098-6
Storage Racks	1098-10

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

1730-3 CONSTRUCTION METHODS**(A) General**

Provide cable manufacturer's attenuation and Optical Time Domain Reflectometer (OTDR) testing data for each reel of cable upon request.

Install SMFO communications cable, snow shoes, communications cable identification markers, lashing wire and all necessary hardware.

Comply with manufacturer's recommendations. Install communications cable on signal poles, utility poles, messenger cable and in conduits as required to bring the fiber-optic cable into and, if necessary, out of each splice enclosure.

Take all precautions necessary to ensure cable is not damaged during storage, handling and installation. Do not violate minimum bending radius of 20 times the radius of cable diameter or manufacturer's recommendation, whichever is greater. Do not step on cable nor run over cable with vehicles or equipment. Do not pull cable over or around obstructions or along the ground.

Determine lengths of cable necessary to reach from termination-point to termination-point. Install cable in continuous lengths between approved splicing facilities. Additionally, provide a sufficient amount of slack cable to allow for an additional 20 ft of cable to be present after removal of outer sheath for termination. Measure slack cable by extending cable straight out of cabinet door.

Keep cable ends sealed at all times during installation to effectively prevent the ingress of moisture. Use approved heat shrink cable end cap. Do not use tape to seal cable ends.

Before installing cable, provide 3 copies of cable manufacturer's recommended and maximum pulling tension. Do not exceed manufacturer's recommended pulling tension. Use pulling grips containing a rotating swivel. Coil cable in a figure-8 configuration whenever cable is unreeled for subsequent pulling.

Install fiber-optic cable in separate 2" risers with heat shrink tubing or conduits. Do not share risers or conduits containing fiber-optic cable with other type cable.

Section 1730

1 (B) Aerial Installation

2 Double lash fiber-optic cable to messenger cable with one 360° spiral per foot.

3 Use pole attachment hardware and roller guides with safety clips to install aerial run
4 cable.

5 Maintain tension during the pulling process for aerial run cable by using an approved
6 mechanical clutch (dynamometer) device. Do not allow cable to contact the ground or
7 other obstructions between poles during installation. Do not use a motorized vehicle to
8 generate cable pulling forces.

9 Use a cable suspension clamp when attaching cable tangent to a pole. Select and place
10 cable blocks and corner blocks so as not to exceed the cable's minimum bending radius.
11 Do not pull cable across J-hooks.

12 Store 100 ft of each fiber-optic cable on all cable runs that are continuous without splices
13 where specified. Obtain approval for spare cable storage locations. Store spare fiber-
14 optic cable on fiber-optic cable storage racks (snow shoes). Locate spare cable storage in
15 the middle of spans between termination points. Do not store spare fiber-optic cable over
16 the roadway or driveways.

17 Install one communications cable identification marker within 36" of pole attachment
18 points and at locations where more than one cable originates or terminates.

19 (C) Underground Installation

20 Install fiber-optic cable underground in conduit using cable pulling lubricants
21 recommended by the fiber-optic cable manufacturer.

22 Obtain approval of cable pulling lubricant and method of pulling before installing
23 underground fiber-optic cable.

24 Use a dynamometer (clutch device) so as not to exceed maximum allowable pulling
25 tension if cable is pulled by mechanical means. Do not use a motorized vehicle to
26 generate cable pulling forces.

27 Keep tension on cable reel and pulling line at start of each pull. Do not release tension if
28 pulling operation is halted. Restart pulling operation by gradually increasing tension
29 until cable is in motion.

30 For pulling cable through manholes, junction boxes and vaults, feed cable by manually
31 rotating the reel. Do not pull cable through intermediate junction boxes, handholds or
32 openings in conduit unless otherwise approved.

33 Install communications cable identification markers on each communications cable
34 entering a junction box.

35 (D) Installation of Drop Cable Assembly

36 Determine length of drop cable needed, including slack, to reach from termination point
37 to termination point.

38 At aerial splice enclosures, store 100 ft of slack cable on cable storage racks. At below
39 ground splice enclosures, coil 100 ft of slack cable in manhole or junction box where
40 enclosure is located.

41 At equipment cabinet end of drop cable assembly, terminate all fibers with
42 ST-PC connectors to the connector panel. Label all connectors, pigtails and the
43 connector panel. At the aerial splice enclosure location, cap off all unused fibers and
44 label to correspond with the connector panel.

1 **1730-4 MEASUREMENT AND PAYMENT**

2 *Communications Cable* (____-Fiber) will be measured and paid as the actual linear feet of
 3 fiber-optic cable of each fiber count furnished, installed and accepted. Measurement will be
 4 made by calculating the difference in length markings located on outer jacket from start of run
 5 to end of run for each run. Terminate all fibers before determining length of cable run.

6 *Drop Cable* will be measured and paid as linear feet of fiber-optic drop cable assemblies
 7 furnished, installed and accepted. Sag and vertical segments will not be paid as these
 8 distances are incidental to the installation of drop cable assemblies.

9 No measurement will be made for terminating, splicing and testing fiber-optic cable,
 10 communications cable identification markers or fiber-optic cable storage racks, as these will
 11 be incidental to the installation of fiber-optic cable.

12 Payment will be made under:

Pay Item	Pay Unit
Communications Cable (____-Fiber)	Linear Foot
Drop Cable	Linear Foot

13

SECTION 1731

14

FIBER-OPTIC SPLICE CENTERS15 **1731-1 DESCRIPTION**

16 Furnish and install fiber-optic interconnect centers, fiber-optic splice enclosures and all
 17 necessary hardware.

18 Modify existing fiber optic interconnect centers and/or splice enclosures as shown in the
 19 plans. Refer to manufacturer's recommendations for opening, modifying and re-sealing the
 20 existing fiber optic interconnect center and/or fiber optic splice enclosures.

21 **1731-2 MATERIALS**

22 Refer to Division 10.

Item	Section
Fiber-Optic Splice Centers	1098-11

23 Furnish material, equipment and hardware under this section that is pre-approved on the
 24 ITS and Signals QPL.

25 **1731-3 CONSTRUCTION METHODS**26 **(A) General**

27 Include on the cover of each splice tray in a legible format the following information:

28 (1) Splice location reference number or identification information
 29 (i.e. 06-1011 tray 1 of 3, 06-1011 tray 2 of 3, etc.)

30 (2) Date the splice was made

31 (3) Company name of individual performing the splicing

32 (4) Name of individual performing the splicing

Section 1731

1 (B) Workmanship

2 Upon cutting the cable and removing the outer jacketing material down to the individual
3 buffer tubes, secure the central strength member to the enclosure so that no tensile force
4 is applied to the fibers. Secure the individual buffer tubes to the splice trays by a method
5 recommend by the manufacturer. Determine the length of each buffer tube needed to
6 ensure the buffer tube can be looped a minimum of two times around the inside the splice
7 tray. Upon determining the length of buffer tube needed remove the buffer tube to
8 expose the individual fibers for fusion splicing. Adjust individual fiber lengths as
9 necessary to ensure that once the fusion splicing process is completed that the finished
10 splices will align with the “splice block organizer” supplied within the splice tray.
11 Ensure the slice block organizer has individual fusion splice space holders for each fiber
12 splice.

13 While prepping the individual fibers for splicing install the heat shrink protecting tube
14 over the fiber and then perform the splicing operations, following the manufacturer’s
15 instructions. Verify the newly formed splice does not exceed 0.05 dB of attenuation.
16 If the attenuation is more than 0.05 dB then remake the splice until it meets the 0.05 dB
17 or less requirement. Finish the splicing operation by sliding the heat shrink tube over the
18 splice and applying heat to activate the heat shrink tubing. Secure the finished splice in
19 the splice block organizer. Ensure each splice is properly secured in a space holder in the
20 splice block organizer. Multiple splices secured to the same space holder are
21 unacceptable.

22 Ensure all buffer tubes are contained within splice trays so no bare fibers are outside tray
23 and do not damage the fiber or violate the minimum bending radius of the fiber.

24 Prior to installing the cover over the splice tray and placing it in its final resting location,
25 take a MANDATORY digital photograph of the splice tray that shows the final
26 workmanship. Ensure the photograph shows the “Workmanship Identification
27 Information” as well as the workmanship associated with installing and terminating the
28 fiber. Include digital copies of each photograph on a compact disk as part of the
29 OTDR Test Results submittal.

30 (C) Termination and Splicing within Interconnect Center

31 Install interconnect centers with connector panels, splice trays, storage for slack cable or
32 fibers, mounting and strain relief hardware and all necessary hardware.

33 Terminate and splice all fibers including unused fibers.

34 Label all fiber-optic connectors, whether on jumpers, connector panels or other
35 equipment, to prevent improper connection. Obtain approval of fiber-optic connector
36 labeling method.

37 For all fibers designated for termination to connector panel within interconnect center,
38 fusion splice fibers to pigtails.

39 For all cut fibers designated to pass through interconnect center, fusion splice fibers.

40 For all buffer tubes designated to pass through interconnect center, neatly coil excess
41 tubing inside interconnect center.

42 (D) Termination and Splicing within Interconnect Center

43 Terminate and splice all fibers including unused fibers.

44 Label all fiber-optic connectors, whether on jumpers, connector panels or other
45 equipment, to prevent improper connection. Obtain approval of fiber-optic connector
46 labeling method.

1 For all fibers designated for termination to connector panel within interconnect center,
2 fusion splice fibers to pigtails.

3 For all cut fibers designated to pass through interconnect center, fusion splice fibers.

4 For all buffer tubes designated to pass through interconnect center, neatly coil excess
5 tubing inside interconnect center.

6 **(E) Termination and Splicing within Splice Enclosure**

7 Install splice enclosures with splice trays, basket containment assemblies, racking for
8 slack cable or fibers, mounting and strain relief hardware, and all other necessary
9 hardware.

10 Fusion splice all fibers including fibers designated to be coupled with fibers from a drop
11 cable assembly and cut fibers designated to pass through splice enclosure.

12 For all buffer tubes designated to pass through splice enclosure, neatly coil excess tubing
13 inside basket provided with enclosure.

14 Label all fiber-optic splices. Obtain approval of fiber-optic connector labeling method.

15 Install heat shrink cable shields using methods recommended by the manufacturer of the
16 enclosure. Perform a pressurization flash test on enclosure in accordance with
17 manufacturer's recommended procedures at the conclusion of splicing procedure and
18 before final placement of enclosure.

19 For aerial installations, secure enclosures to messenger cable using manufacturer supplied
20 hardware. Secure SMFO cable and drop cable assemblies to snowshoes.

21 Install enclosures with enough slack cable to allow enclosure to be lowered to ground
22 level and extended into a splicing vehicle.

23 For underground, manhole, and junction box facility installations, place the enclosure
24 along with required spare cables in the facility in a neat and workmanship like manner.

25 **(F) Modify Interconnect Center and Splice Enclosure**

26 Modify existing fiber optic interconnect centers and/or splice enclosures as shown in the
27 plans. Install additional patch panels, splice trays and pigtails where necessary and
28 fusion splice fiber connections and perform OTDR testing as required by the plans.
29 Install new fiber optic jumpers and make connections to equipment and/or patch panels
30 as necessary.

31 **(G) Testing**

32 Provide written notification a minimum of 10 days before beginning OTDR tests.

33 After splicing is completed, perform bi-directional OTDR tests on each fiber, including
34 unused fibers. Install a 1,000-ft pre-tested launch cable between the OTDR and fiber
35 optic cable to be tested and a 1,000-ft pre-tested destination cable on the end of the fiber
36 optic cable to be tested. Ensure each launch cable has been tested and is compatible with
37 the fiber being installed. Provide Engineer with test results of the launch cable before
38 use. Re-test or replace launch cable at Engineer's request.

39 Ensure fusion splice losses do not exceed 0.05 dB and connectors have a loss of 0.5 dB or
40 less. If any fiber exceeds maximum allowable attenuation or if fiber properties of the
41 cable have been impaired, take appropriate actions up to and including replacement of the
42 fiber cable.

Section 1732

1 Clearly label each OTDR trace identifying a starting and ending point for all fibers being
2 tested. Record the attenuation level of each fiber and clearly indicate OTDR trace results
3 in report format. Furnish 2 hard copies of each of the OTDR trace results and electronic
4 copies of all trace results along with digital photographs showing workmanship for each
5 splice on a compact disk. Furnish the manufacturer’s make, model number and software
6 version of the OTDR used for testing.

7 Furnish to the Engineer 2 copies of the software needed to view the OTDR traces
8 electronically.

9 **1731-4 MEASUREMENT AND PAYMENT**

10 *Interconnect Center* will be measured and paid as the actual number of fiber-optic
11 interconnect centers furnished, installed and accepted.

12 *Splice Enclosure* will be measured and paid as the actual number of fiber-optic splice
13 enclosures furnished, installed and accepted. No measurement will be made between aerial,
14 underground, manhole or junction box installation of the fiber-optic splice enclosure.

15 *Modifying Splice Enclosure* will be measured and paid as the actual number of fiber-optic
16 splice enclosures modified and accepted. No measurement will be made between aerial,
17 underground, manhole or junction box installation of the fiber-optic splice enclosure.

18 No measurement will be made of splice trays, pigtails, jumpers, connector panels, testing and
19 any corrective actions, repairs and replacements needed for exceeding maximum allowable
20 attenuation or other defects, as these will be incidental to furnishing and installing fiber-optic
21 interconnect centers and splice enclosures and modifying splice enclosures.

22 Payment will be made under:

Pay Item	Pay Unit
Interconnect Center	Each
Splice Enclosure	Each
Modifying Splice Enclosure	Each

23 **SECTION 1732**
24 **FIBER-OPTIC TRANSCEIVERS**

25 **1732-1 DESCRIPTION**

26 Furnish and install fiber-optic transceivers with all necessary hardware.

27 **1732-2 MATERIALS**

28 Refer to Division 10.

Item	Section
Fiber-Optic Transceivers	1098-12

29 Furnish material, equipment and hardware under this section that is pre-approved on the
30 ITS and Signals QPL.

31 **1732-3 CONSTRUCTION METHODS**

32 Install fiber-optic transceivers in each equipment cabinet and comply with manufacturer’s
33 installation instructions.

34 **1732-4 MEASUREMENT AND PAYMENT**

35 *Fiber-Optic Transceiver - Drop and Repeat* will be measured and paid as the actual number
36 fiber-optic drop and repeat transceivers furnished, installed and accepted.

37 *Fiber-Optic Transceiver - Self-Healing Ring* will be measured and paid as the actual number
38 of fiber-optic self-healing ring transceivers furnished, installed and accepted.

1 Payment will be made under:

Pay Item	Pay Unit
Fiber-Optic Transceiver - Drop and Repeat	Each
Fiber-Optic Transceiver - Self-Healing Ring	Each

2

SECTION 1733

3

DELINEATOR MARKERS

4 **1733-1 DESCRIPTION**

5 Furnish and install delineator markers with all necessary hardware.

6 **1733-2 MATERIAL**

7 Refer to Division 10.

Item	Section
Delineator Markers	1098-13

8 Furnish material, equipment and hardware under this section that is pre-approved on the
9 ITS and Signals QPL.

10 **1733-3 CONSTRUCTION METHODS**

11 Submit sample of proposed delineator markers for approval before installation.

12 Install delineator markers using a method that firmly and securely anchors delineator marker
13 in the ground to prohibit twisting and easy removal.

14 **1733-4 MEASUREMENT AND PAYMENT**

15 *Delineator Marker* will be measured and paid as the actual number delineator markers
16 furnished, installed and accepted.

17 Payment will be made under:

Pay Item	Pay Unit
Delineator Marker	Each

18

SECTION 1734

19

REMOVE EXISTING COMMUNICATIONS CABLE

20 **1734-1 DESCRIPTION**

21 Remove existing communications cable.

22 **1734-2 CONSTRUCTION METHODS**

23 Removal of existing aerial communications cable also includes proper disposal of
24 communications cable, messenger cable and mounting hardware, including abandoned risers.

25 Removal of existing underground communications cable includes proper disposal of
26 communications cable and junction boxes, if required. Where junction boxes have been
27 removed, backfill hole to 95% of surrounding density.

28 Do not reuse any removed communications cable, messenger cable, junction boxes, pole
29 attachment hardware or abandoned risers on the project, unless otherwise specified. In the
30 event that any of the removed communications cable, junction boxes or pole attachment
31 hardware is to be returned to the Engineer, it will be so noted in the plans.

Section 1735

1 **1734-3 MEASUREMENT AND PAYMENT**

2 *Remove Existing Communications Cable* will be measured in horizontal linear feet of existing
3 communications cable removed and accepted. Payment will be in linear feet. Sag, vertical
4 segments or spare segments of communications cable will not be paid as these distances will
5 be incidental to the removal of existing communications cable.

6 No additional measurement will be made for multiple cables being removed from the same
7 conduit or same pole. Where multiple adjacent conduits exist (each containing multiple
8 cables), each conduit will be measured and paid separately. No payment will be made for
9 cable that cannot be removed and is abandoned in place.

10 No measurement will be made of the removal of messenger cable, pole attachment hardware
11 and junction boxes, as these will be incidental to removing existing communications
12 hardware.

13 Payment will be made under:

Pay Item	Pay Unit
Remove Existing Communications Cable	Linear Foot

14 **SECTION 1735**
15 **CABLE TRANSFERS**

16 **1735-1 DESCRIPTION**

17 Remove and reinstall existing communications cable for pole relocations.

18 **1735-2 CONSTRUCTION METHODS**

19 During project, transfers of existing communications cable to new poles may be required.
20 Perform transfers as directed by the Engineer. Remove existing cables from pole to be
21 removed and reinstall these cables and any existing attachment hardware on new pole.
22 Remove all communications hardware from existing pole. Furnish and install any new
23 attachment hardware as required.

24 **1735-3 MEASUREMENT AND PAYMENT**

25 *Cable Transfer* will be measured and paid as the actual number of cable transfers with
26 attachment hardware to new poles furnished, installed and accepted.

27 Payment will be made under:

Pay Item	Pay Unit
Cable Transfer	Each

28 **SECTION 1736**
29 **SPREAD SPECTRUM RADIO**

30 **1736-1 DESCRIPTION**

31 Furnish and install a spread spectrum radio system with all necessary hardware and signage in
32 accordance with the plans and specifications to provide a data link between field devices
33 (i.e. traffic signal controllers, dynamic message signs, etc.). Provide a radio system with
34 a bi-directional, full duplex communications channel between 2 “line-of-sight” antennas using
35 license free, spread spectrum technology operating in the 902-928 MHz frequency band.

36 Furnish material and workmanship conforming to the NEC, the NESC, UL or a third-party
37 listing agency accredited by the North Carolina Department of Insurance and all local safety
38 laws. Comply with all regulations and codes imposed by the owner of affected utility poles.

1 **1736-2 MATERIAL**

2 Refer to Division 10.

Item	Section
Pole Line Hardware	1098-6
Retroreflective Sheeting	1092-2
Signs and Hardware	1092-1
Spread Spectrum Radio	1098-18
Wire	1091-2

3 **1736-3 CONSTRUCTION METHODS**4 **(A) General**

5 Perform a radio path Site Survey test before installing any equipment. Ensure the test
6 evaluates the signal strength (dBm), fade margin (dB), signal-to-noise ratio, data integrity
7 (poll test) and a complete frequency spectrum scan. Ensure the radio path site survey test
8 is performed using the supplied brand of radio equipment to be deployed. During the
9 initial radio path signal strength test it may be determined that a repeater station may be
10 necessary to complete the intended link. Provide the test results to the Engineer for
11 review and approval. Submit copies of the test results and colored copies of the
12 frequency spectrum scan along with an electronic copy of this information. The Engineer
13 will approve final locations of antennas and any necessary repeater stations. Install
14 a coaxial cable, power divider, antenna splitter cable and additional antenna at locations
15 where it is determined that a dual antenna configuration is necessary to accommodate
16 communications in multiple directions.

17 Install the antenna in such a manner that avoids conflicts with other utilities (separation
18 distances in accordance with the guidelines of the NESC) and as specified in the antenna
19 manufacturer's recommendations. Secure the antenna mounting hardware to the pole and
20 route the coaxial cable such that no strain is placed on the N-Type male coaxial
21 connectors. On wood pole installations, bond the antenna mounting hardware to the pole
22 ground using #6 AWG bare copper wire using split bolt or compression type fitting.

23 Install the coaxial cable shield grounding system by carefully removing the outer jacket
24 of the coaxial cable without damaging the cable shield. Install the shield grounding
25 system following the cable manufacturer's recommendations. Install and weatherproof
26 the connection using the appropriate weatherproofing materials and following the
27 manufacturer's recommendations. On wood poles, secure the #6 AWG grounding lead
28 cable to the pole ground using split bolt or compression type fitting or a method approved
29 by the Engineer. On metal poles, secure the #6 AWG grounding lead cable to the pole
30 using a method approved by the Engineer.

31 Do not exceed the one inch bend radius of the coaxial cable as it traverses from the
32 cabinet to the antenna assembly. Connect the lightning arrestor to the coaxial cable in the
33 equipment cabinet. Properly ground and secure the arrestor in the cabinet. Permanently
34 label all cables entering the cabinet. Ensure the power supply for the radio system is not
35 connected to the GFCI receptacle circuit located in the cabinet. Place a copy of all
36 manufacturer equipment specifications and instruction and maintenance manuals in the
37 equipment cabinet.

38 At certain locations it may be necessary to integrate the radio system with a fiber optic
39 system. Follow the details shown in the fiber optic splice plans.

Section 1743

(B) Disconnect Switch

At all locations, where the antenna is mounted on a joint use pole, install a double pole, snap switch to remove power from the spread spectrum radio system. Do not mount weatherproof box on the traffic signal cabinet door. Drill a hole in the side of the traffic signal cabinet. Mount the outlet box over the hole using a half inch chase nipple and bushings. Ensure sealing gaskets are in place and no water can enter the cabinet. Securely mount the weatherproof outlet box with additional mounting screws. Bond the outlet box to the equipment ground bus. See plans for approximate mounting height. Run the power supply cord of the spread spectrum radio unit into the outlet box and connect to switch. Securely attach power supply cord to equipment rack. Install disconnect switch with lockout tag cover. If the antenna is mounted on a joint use pole, the “disconnect switch” is required.

Do not install power supply for the radio in a GFCI protected outlet.

(C) Warning Sign(s) and Decal(s)

At all locations, where the antenna is mounted on a joint use pole, secure a warning sign to pole. Mount warning sign(s) at locations called for in the plans. Ensure there are no conflicts between the warning sign and surrounding utilities. Mount warning sign to be easily viewed. Do not mount warning sign under pole grounds or conduit. If the antenna is mounted on a joint use pole, the RF warning sign is required.

Clean and remove any dirt or oil on traffic cabinet before placing decal. Place decal adjacent to the disconnect switch located on the outside of traffic cabinet. If the antenna is mounted on a joint use pole, the decal is required.

1736-4 MEASUREMENT AND PAYMENT

900MHz Radio will be measured and paid as the actual number of 900 MHz radios furnished, installed and accepted. This item includes the appropriate sized antenna(s), radio, power supplies, disconnect/snap switch, signs, decals, data interface cable/serial cable, coaxial cable, lightning arrestor, radio frequency signal jumper, coaxial cable power divider (splitter), coaxial cable connectors, coaxial cable shield grounding system with weatherproofing, labeling and any integration between the radio system and a fiber optic network if necessary, installation materials and configuration software necessary to complete this work, including the radio path Site Survey test and warranties.

Payment will be made under:

Pay Item	Pay Unit
900MHz Radio	Each

**SECTION 1743
PEDESTALS**

1743-1 DESCRIPTION

Furnish and install the size and type of support assembly for vehicular or pedestrian signal heads, pedestrian pushbuttons, Intelligent Transportation System technologies or other traffic control devices as shown in the plans. Furnish assembly with foundation, grounding system and all necessary hardware as shown in the *Roadway Standard Drawings*. Provide a pedestal assembly that meets *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* in effect on the date of project advertisement. Unless otherwise required by the plans, install signal pedestals and pedestrian pushbutton posts on FHWA-approved breakaway support or anchor systems.

1 **1743-2 MATERIAL**

2 Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Signal Pedestals	1098-14
Wire	1091-2

3 Furnish material, equipment and hardware under this section that is pre-approved on the
4 ITS and Signals QPL.

5 Pedestals are defined as follows:

6 (A) Type I - Pedestrian Pushbutton Post

7 (B) Type II - Normal-Duty Pedestal

8 (C) Type III - Heavy-Duty Pedestal

9 **1743-3 CONSTRUCTION METHODS**10 **(A) Type I Pedestrian Pushbutton Post**11 Install pushbutton post for mounting pedestrian pushbutton or an accessible pedestrian
12 signal (APS) assembly (refer to Section 1705).13 Install underground conduit for pushbutton lead-in cable in the pushbutton post's
14 concrete foundation.15 Attach or anchor pushbutton post to the top of foundation via a breakaway support in
16 a vertical plumb orientation. Ensure post is of sufficient length to accommodate the
17 pushbutton, accessible pedestrian signals and any associated pedestrian informational
18 signing at the mounting heights shown in the plans or *Roadway Standard Drawings*
19 No. 1705 and 1743.20 **(B) Type II and III Pedestals**21 Locate foundations, determine elevation and submit findings for normal-duty and
22 heavy-duty pedestals. Obtain the Engineer's approval of foundation locations and
23 elevations before constructing foundations.24 Excavate in accordance with Section 410. If encountered, remove rock or boulders to
25 a sufficient depth to obtain stability necessary to support the structure for design loads.
26 Ensure ground is level before installing foundations.27 Construct foundations in accordance with Section 825. Cast concrete for pole
28 foundations against undisturbed soil unless otherwise permitted. Provide forms with
29 chamfer strips that measure one inch along diagonal face at all corners above ground
30 level. Do not install foundations over uncompacted fill or muck.

31 Install conduit in foundations.

32 Securely place, position and align anchor bolts symmetrically about the center of
33 foundation.34 Give exposed vertical concrete surfaces an ordinary surface finish. Give exposed
35 horizontal surfaces a float finish.36 Level tops of concrete foundations. Do not allow tops to exceed 4" above adjacent
37 ground surface. Pour and finish foundation to a level that is flush with the surrounding
38 sidewalk when possible.

Section 1745

1 Do not erect pedestals until concrete has attained a minimum compressive strength of
2 2,500 psi as determined by cylinder breaks.

3 Refer to *Roadway Standard Drawings* No. 1705 and 1743.

4 **1743-4 MEASUREMENT AND PAYMENT**

5 *Type I Post with Foundation* will be measured and paid as the actual number of pedestrian
6 pushbutton posts furnished, installed and accepted.

7 *Type II Pedestal with Foundation* will be measured and paid as the actual number of normal-
8 duty pedestals with foundations furnished, installed and accepted.

9 *Type III Pedestal with Foundation* will be measured and paid as the actual number of heavy-
10 duty pedestals with foundations furnished, installed and accepted.

11 No measurement will be made for pedestal foundations, grounding systems and any
12 peripheral pedestal mounting hardware as these are incidental to furnishing and installing
13 pedestals.

14 Payment will be made under:

Pay Item	Pay Unit
Type I Post with Foundation	Each
Type II Pedestal with Foundation	Each
Type III Pedestal with Foundation	Each

15 **SECTION 1745**
16 **SIGNS INSTALLED FOR SIGNALS**

17 **1745-1 DESCRIPTION**

18 Furnish and install signs for signals with cable hangers, rigid sign mounting brackets,
19 U-channel posts and all necessary hardware.

20 **1745-2 MATERIAL**

21 Refer to Division 10.

Item	Section
Signs and Hardware	1092-1
Retroreflective Sheeting	1092-2

22 Use Grade C retroreflective sheeting, except for black sheeting. Use non-reflective for black
23 sheeting.

24 Conform to the message layout, size and color as required in the MUTCD.

25 For messenger cable mounting, furnish either messenger cable hangers with free-swinging,
26 360° adjustable sign brackets or 3-bolt clamps as directed. Furnish aluminum, galvanized
27 steel or stainless steel sign supporting hardware.

28 For ground mounting, furnish steel, 3 lb, U-channel posts with hardware for ground mounting.
29 Comply with Section 903.

30 For mast-arm mounting, furnish rigid aluminum, galvanized steel or stainless steel sign
31 mounting brackets.

32 **1745-3 CONSTRUCTION METHODS**

33 Install signs with applicable mounting hardware. Comply with sign offsets and mounting
34 heights as shown in the MUTCD and the *Roadway Standard Drawings* No. 904.50.

35 For messenger cable mounting, install signs 6" minimum from signal heads.

- 1 For ground mounting, comply with Article 903-3.
 2 For mast arm mounting, install attachment brackets to allow adjustment so signs:
 3 (A) Are aimed in required direction,
 4 (B) Are plumb as viewed from respective approaches,
 5 (C) May be tilted forward or backward as required, and
 6 (D) May be raised or lowered on mast arm throughout full length of sign.

7 **1745-4 MEASUREMENT AND PAYMENT**

8 *Sign for Signals* will be measured and paid as the actual number of signs for signals,
 9 regardless of mounting method, furnished, installed and accepted.

10 Payment will be made under:

Pay Item	Pay Unit
Sign for Signals	Each

11 **SECTION 1746**
 12 **RELOCATE EXISTING SIGN**

13 **1746-1 DESCRIPTION**

14 Relocate existing signs.

15 **1746-2 CONSTRUCTION METHODS**

16 As directed by the plans, relocate existing signs. Comply with Article 1745-3.

17 **1746-3 MEASUREMENT AND PAYMENT**

18 *Relocate Existing Sign* will be measured and paid as the actual number of existing signs,
 19 regardless of mounting method, relocated and accepted.

20 Payment will be made under:

Pay Item	Pay Unit
Relocate Existing Sign	Each

21 **SECTION 1747**
 22 **LED BLANKOUT SIGN**

23 **1747-1 DESCRIPTION**

24 Furnish and install Light Emitting Diode (LED) blankout signs with all necessary hardware as
 25 set forth in the plans and specifications. Design the signs with the options to display "NO
 26 (LEFT or RIGHT) TURN TRAIN". Fabricate the sign to be between 27" and 29" wide,
 27 between 37" and 39" high and approximately 8" deep.

28 **1747-2 MATERIAL**

29 Furnish material, equipment and hardware under this section that is pre-approved on the
 30 ITS and Signals QPL.

31 **1747-3 CONSTRUCTION METHODS**

32 Install LED blankout signs with wire entrance fittings, span wire cable mounting assemblies,
 33 pedestal mounting assemblies, signal cable, lashing wire and all necessary hardware.

34 Relocate existing blankout signs with all necessary hardware.

Section 1750

1 **1747-4 MEASUREMENT AND PAYMENT**

2 *LED Blankout Signs* will be measured and paid as the actual number of LED blankout signs
3 with mounting hardware furnished, installed and accepted.

4 *Relocate Existing Blankout Sign* will be measured and paid as the actual number of blankout
5 signs relocated and accepted.

6 Payment will be made under:

Pay Item	Pay Unit
LED Blankout Signs	Each
Relocate Existing Blankout Sign	Each

7 **SECTION 1750**
8 **SIGNAL CABINET FOUNDATIONS**

9 **1750-1 DESCRIPTION**

10 Furnish and install signal cabinet foundations and all necessary hardware.

11 Furnish either poured concrete foundations or preformed cabinet pad foundations and all
12 necessary hardware. Obtain approval of foundation type.

13 **1750-2 MATERIAL**

14 Refer to Division 10.

Item	Section
Signal Cabinet Foundation	1098-15
Portland Cement Concrete	1000-4

15 Furnish preformed cabinet pad foundation material, equipment and hardware under this
16 section that is pre-approved on the ITS and Signals QPL.

17 **1750-3 CONSTRUCTION METHODS**

18 Comply with Section 825.

19 When using poured concrete foundations, use procedures, equipment and hardware as
20 follows:

- 21 **(A)** Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.
- 22 **(B)** Obtain approval for final cabinet foundation locations before pouring concrete base.
- 23 **(C)** Do not install foundations over uncompacted fill or muck.
- 24 **(D)** Hand tamp soil before placing concrete and ensure ground is level.
- 25 **(E)** Maintain 12" minimum from service pole to closest point on foundation unless otherwise
26 approved.
- 27 **(F)** Use a minimum of four 1/2" diameter expanding type anchor bolts to secure cabinet to
28 foundation.
- 29 **(G)** Install minimum 4" above and 4" below finished grade.
- 30 **(H)** Locate external stubbed out conduit at cabinet foundation so conduit is in middle of
31 cabinet. Provide service conduit as the rightmost conduit coming into cabinet. Provide
32 2 spare conduits stubbed out; one pointed toward service pole and the other toward
33 direction of lead in cable. Inscribe identification arrow in foundation indicating direction
34 of spare conduits.

- 1 **(I)** Give cabinet foundation a broom finish.
- 2 **(J)** Seal space between cabinet base and foundation with permanent, flexible, waterproof
3 sealing material.
- 4 If using a preformed cabinet pad, follow applicable procedures in Subarticles 1750-3(A)
5 through 1750-3(J).

6 **1750-4 MEASUREMENT AND PAYMENT**

7 *Signal Cabinet Foundation* will be measured and paid as the actual number furnished,
8 installed and accepted.

9 Payment will be made under:

Pay Item	Pay Unit
Signal Cabinet Foundation	Each

10

SECTION 1751

11

CONTROLLERS WITH CABINETS

12 **1751-1 DESCRIPTION**

13 Furnish and install controllers with cabinets and all necessary hardware. Furnish all pole or
14 foundation mounting hardware, detector sensor cards, external electrical service disconnects,
15 one Corbin Number 2 cabinet key, one police panel key, conflict monitors or malfunction
16 management units, surge protection, grounding systems, AC/DC isolator cards and all
17 necessary hardware.

18 **1751-2 MATERIAL**

19 Furnish material, equipment and hardware under this section that is pre-approved on the
20 ITS and Signals QPL.

21 **1751-3 CONSTRUCTION METHODS**

22 **(A) General**

23 Remove existing controllers and cabinets where required. Remove maintenance diary
24 from cabinet and place in new cabinet or deliver to the Engineer. Take existing
25 equipment out of service only at the time directed.

26 Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.

27 Install controllers, cabinets, detector sensor units and hardware that provide required
28 phasing, color sequence, flash sequence, interconnection, railroad clearance and
29 preemption and emergency vehicle clearance and preemption.

30 Stencil signal inventory number on cabinet side facing roadway. Use 3" black characters.

31 Provide external electrical service disconnect at all new and existing cabinet locations
32 unless otherwise specified.

33 Do not program controller for late night flashing operation at railroad preemption
34 installations. For all other installations, do not program controller for late night flashing
35 operation unless otherwise directed. Ensure all signal heads for same approach flash
36 concurrently during flashing operation.

37 Provide serial number and cabinet model number for each new controller and controller
38 cabinet installed.

39 Install pole mounted cabinets so height to cabinet middle is 4 ft.

40 Activate controllers with proposed phasing and timing.

Section 1752

1 **(B) System Interconnection**

2 When interconnection of signals is required (via fiber optics, twisted pair, ethernet,
3 wireless, etc.), install communications interface equipment and hardware for signals.
4 Demonstrate proper operation of interconnection using manual commands and
5 upload/download capability to each local controller from the respective master controller
6 after interconnection is complete.

7 Program telemetry command sequences and enable devices necessary for testing of
8 communication between local controllers and field master controllers and between field
9 master controllers and Department-furnished central computer.

10 **(C) Workshop**

11 Provide enclosed workshop to set up and test new controllers and cabinets before
12 installation. Locate workshop within Division responsible for project administration.
13 Ensure workshop provides protection from weather and sufficient space to house 2 test
14 observers, all necessary test equipment and material, controllers and cabinets.

15 Configure and test each controller and cabinet to match the proposed signal design.
16 Ensure all equipment furnished and installed or modified by the Contractor at each
17 location operates in full compliance with the plans and project special provisions. Test
18 each controller and cabinet for proper color sequence, flashing operation, phase timings,
19 preemption, coordination and conflict monitor programming or malfunction management
20 unit programming. Ensure that simultaneous conflicting phase outputs will cause the
21 cabinet to revert to flashing operation. For intersections with any type of preemption,
22 submit a completed Preemption Test Procedure Checklist. The checklist is located on the
23 Department's website.

24 Test the cabinet and controller for eight hours minimum. Following this test and before
25 installation, the Engineer will inspect the equipment in operation. The Engineer may
26 require other tests to ensure proper operation. These tests shall be at no additional cost to
27 the Department.

28 **1751-4 MEASUREMENT AND PAYMENT**

29 *Controllers with Cabinet* (____) will be measured and paid as the actual number of each type
30 of controllers with cabinets furnished, installed and accepted.

31 *Detector Card* (____) will be measured and paid as the actual number furnished, installed and
32 accepted.

33 No measurement will be made of conflict monitors, malfunction management units, external
34 electrical service disconnect, grounding systems, modems, meter bases and workshop as these
35 will be incidental to furnishing and installing controllers with cabinets.

36 Payment will be made under:

Pay Item	Pay Unit
Controllers with Cabinet (____)	Each
Detector Card (____)	Each

37 **SECTION 1752**
38 **MODIFY CABINET FOUNDATIONS**

39 **1752-1 DESCRIPTION**

40 Where approved by the Engineer, install conduit entrances into existing foundations in
41 accordance with the plans and specifications. Modify existing foundations in accordance with
42 the plans and specifications.

1 **1752-2 MATERIAL**

2 Refer to Article 1750-2.

3 **1752-3 CONSTRUCTION METHODS**4 **(A) Install Conduit Entrance into Existing Foundation**5 Install Conduit Entrances into existing cabinet foundations by core drilling foundations to
6 install additional conduit.7 Maintain a minimum of 3" of cover between new conduit and edge of foundation.
8 Maintain minimum clearances of 1" from the flange of the base adapter and 2" from
9 existing conduits. Avoid damaging existing conduit, conductors and anchor bolts.
10 Repair all such damages. Where approved by the Engineer, the foundation may be
11 chipped instead of drilled for conduit entrance. When possible, maintain traffic signal
12 operations while drilling is performed.

13 Bond new metallic conduit to the equipment ground bus.

14 After installation of conduit, place grout to seal around conduit and return the foundation
15 to normal appearance.16 **(B) Modify Foundation**17 Enlarge existing cabinet foundations to accommodate the new cabinet and/or to provide
18 a maintenance technician pad.19 Excavate the ground around the existing foundation to a depth sufficient to expose
20 a minimum of 4" of the foundation below existing grade.21 Rough the sides of the existing foundation from the top to a point 4" below grade by
22 means of a chisel or other method approved by the Engineer.23 Wash the sides of the foundation with water pressurized at 50 psi and thoroughly dry
24 with compressed air.25 Drill holes approximately 12" deep on 12" centers into the existing foundation. Install
26 #4 dowels and epoxy into place. Provide dowels of the lengths in Table 1752-1.

TABLE 1752-1 LENGTH OF DOWEL	
Foundation Extension	Length of Dowel
> 16"	24"
> 6" and < 16"	17"
= 6"	14"

27 Use concrete to install the maintenance technician pad.

28 Form the sides of the modified foundation to a minimum depth of 4" below grade.

29 Position forms so that all existing exposed foundation surfaces at or above grade level
30 will be matched.31 Apply a coating of approved epoxy bonding agent to all exposed roughened concrete
32 surfaces as recommended by the manufacturer.33 Enlarge the foundation to the distance specified for new cabinet foundations. Provide
34 a one inch chamfer on all new outside edges.35 Maintenance technician pads should be added to the foundation to provide a minimum
36 work area of 24" [length] x 30" [width] from both the front and rear doors of the cabinet.

Section 1753

1 **1752-4 MEASUREMENT AND PAYMENT**

2 *Conduit Entrance into Existing Foundation* will be measured and paid as the actual number of
3 conduit entrances drilled into existing cabinet foundations furnished, installed and accepted.

4 *Modify Foundation for Controller Cabinet* will be measured and paid as the actual number of
5 existing cabinet foundations modified and accepted.

6 Payment will be made under:

Pay Item	Pay Unit
Conduit Entrance into Existing Foundation	Each
Modify Foundation for Controller Cabinet	Each

7 **SECTION 1753**
8 **CABINET BASE ADAPTER/EXTENDER**

9 **1753-1 DESCRIPTION**

10 Furnish and install cabinet base adapters and extenders with all necessary hardware for
11 Type 170 cabinets.

12 **1753-2 MATERIAL**

13 Refer to Division 10.

Item	Section
Cabinet Base Adapter or Extender	1098-16

14 Furnish material, equipment and hardware under this section that is pre-approved on the
15 ITS and Signals QPL.

16 **1753-3 CONSTRUCTION METHODS**

17 Install cabinet base adapter at locations requiring new Model 332A cabinet on
18 existing/modified foundation.

19 Install cabinet base extender at locations requiring new Model 332A cabinet on new
20 foundation or existing Model 332A cabinet that does not have cabinet base extender.

21 Where Model 336 cabinet is used as base mount cabinet, install adapter or extender, as
22 required.

23 Use permanent, flexible waterproof sealing material to:

24 (A) Seal between cabinet base and cabinet base adapter/extender,

25 (B) Seal 2-piece cabinet base adapter/extender seams, and

26 (C) Seal space between cabinet base adapter/extender and foundation.

27 **1753-4 MEASUREMENT AND PAYMENT**

28 *Cabinet Base Adapters* will be measured and paid as the actual number furnished, installed
29 and accepted.

30 *Cabinet Base Extenders* will be measured and paid as the actual number furnished, installed
31 and accepted.

32 Payment will be made under:

Pay Item	Pay Unit
Cabinet Base Adapter	Each
Cabinet Base Extender	Each

SECTION 1755
BEACON CONTROLLER ASSEMBLIES

1

2

3 **1755-1 DESCRIPTION**

4 Furnish and install beacon controller assemblies with cabinets. Furnish all pole mounting
5 hardware, solid state flashers, one Corbin Number 2 cabinet key, surge protection, grounding
6 systems and all necessary hardware.

7 **1755-2 MATERIAL**

8 Refer to Division 10.

Item	Section
Beacon Controller Assembly	1098-17
Grounding Electrodes	1091-6
Wire	1091-2

9 Furnish material, equipment and hardware under this section that is pre-approved on the
10 ITS and Signals QPL.

11 **1755-3 CONSTRUCTION METHODS**

12 Remove existing beacon controller assemblies where required. Remove maintenance diary
13 from cabinet and place in new cabinet or deliver to the Engineer. Take existing equipment
14 out of service only at the time directed.

15 Locate new beacon controller assemblies so as not to obstruct sight distance of turning
16 vehicles.

17 Install new beacon controller assemblies. Provide external electrical service disconnect at
18 new and existing cabinet locations unless otherwise specified.

19 Stencil signal inventory number on cabinet side facing roadway. Use 3" black characters.
20 Provide serial number and cabinet model number for each new beacon controller assembly.

21 Install pole mounted cabinets so height to cabinet middle is 4 ft.

22 **1755-4 MEASUREMENT AND PAYMENT**

23 *Beacon Controller Assembly and Cabinet* (____) will be measured and paid as the actual
24 number furnished, installed and accepted.

25 No measurement will be made of surge protectors, external electrical service disconnect,
26 grounding systems and removing existing beacon controller assemblies as these are incidental
27 to furnishing and installing beacon controller assemblies.

28 Payment will be made under:

Pay Item	Pay Unit
Beacon Controller Assembly and Cabinet (____)	Each

29

30

SECTION 1757
REMOVAL OF EXISTING TRAFFIC SIGNALS

31 **1757-1 DESCRIPTION**

32 Remove existing traffic signal materials and associated signal hardware.

Section 1757

1 **1757-2 CONSTRUCTION METHODS**

2 **(A) General**

3 Remove existing traffic signals at the locations indicated in the contract. Maintain and
4 repair traffic signal equipment within the limits of the project until the traffic signal
5 equipment is disconnected and stockpiled.

6 **(B) Removal**

7 Dismantle and remove existing traffic signal equipment and material, excluding joint use
8 poles. Disconnect and remove all Department equipment from joint use poles in
9 a manner that will not damage the poles or existing utilities. Cut electrical conduit and
10 remove to at least 18" below finished ground elevation unless otherwise directed by the
11 Engineer.

12 Install the required regulatory signs in accordance with Sections 900, 901 and 903 of the
13 Standard Specifications before deactivating the traffic signal. Cover the signs with
14 burlap bags until the traffic signal is removed or put into flashing operation.

15 If necessary to flash the traffic signal before removal of the signal equipment,
16 immediately uncover the signs before placing the traffic signal into flashing operation.
17 Operate the flashing operation for a period of time as directed by the Engineer.

18 Deactivate, dismantle and remove the traffic signal after the period of flashing operation
19 or as directed by the Engineer.

20 Use methods to remove the traffic signal that will not result in damage to other portions
21 of the project or facility. Repair damage that results from the Contractor's actions at no
22 additional cost to the Department.

23 Final acceptance of the project is contingent upon the removal of the existing traffic
24 signal. Removal of the existing traffic signal is part of the work required by the final
25 completion date.

26 **(C) Disposal**

27 Remove all Department traffic signal equipment, span poles, messenger cable,
28 interconnect cable and supporting hardware that will not be reused. Assume ownership
29 and promptly transport the removed poles, messenger cable, interconnect cable and
30 supporting hardware. Return all other traffic signal equipment and material to the Traffic
31 Services Office within the Division responsible for the administration of the project.

32 Return the removed equipment and material between the hours of 8:00 a.m. and
33 12:00 p.m. Monday through Thursday or at a time mutually agreed upon by the
34 Contractor and the Engineer. Replace or repair all material lost or damaged during its
35 removal and transit. Label all returned equipment and material to indicate its original
36 location.

37 **1757-3 MEASUREMENT AND PAYMENT**

38 *Traffic Signal Removal* will be measured and paid as the actual number of intersections that
39 were completely cleared of all traffic signal equipment. The traffic signal equipment shall
40 have existed along the roadway before the start of construction on the project, shall have had
41 no changes made to the phasing or timing by the Contractor, shall have had no additional
42 equipment installed by the Contractor during the life of the project (excluding equipment for
43 maintenance) and shall have been removed as a part of the project.

44 Payment will be made under:

Pay Item	Pay Unit
Traffic Signal Removal	Each

INDEX

This index is not intended to be a complete concordance, but is intended to provide general reference where a word or term may be found. It is not intended to express emphasis on that particular referenced location. The entire book is available online and may be searched extensively and specifically for particular words and phrases.

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